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LATE

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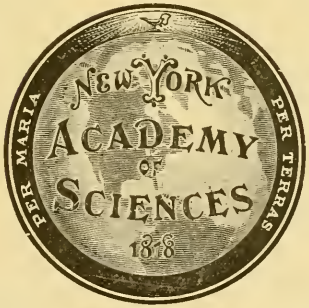
VOLUME IX.

October, 1889, to June, 1890.



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TRANSACTIONS

OF THE

NEW YORK ACADEMY OF SCIENCES.

October 7, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-four persons present.

The report of the Council was read and adopted, recommending the payment of several small bills, and of $165 for the printing of Nos. 5 and 6 of the TRANSACTIONS, and the election as Resident Member of

MR. THOMAS SCOTT FISKE.

The Publication Committee reported through its chairman, PROF. MARTIN, that there had been issued during the summer Nos. 5 and 6 of Vol. VIII. of the TRANSACTIONS, and that Nos. 7 and 8, completing the volume, were printed, but not yet issued. He showed the numbers in unbound sheets, and stated that with them would appear the new and revised edition of the Charter, Constitution, and By-Laws, and lists of Resident, Honorary, and Corresponding Members. Of the ANNALS, No. 12, the concluding part of Vol. IV., was likewise in print, but awaiting revision of the closing article by the authors, and would soon appear. Work had also been commenced on Vol. V., No. 1.

The following papers were then presented and read by title:—

I. COLEOPTEROLOGICAL NOTICES.

BY THOMAS L. CASEY.

II. A LIST OF THE LEPIDOPTERA HITHERTO OBSERVED IN THE VICINITY OF NEW YORK CITY, WITH NOTES ON THEIR FOOD-PLANTS.

BY WILLIAM BEUTTENMULLER.

These will appear in the ANNALS, Vol. V.

Reports of work and observations during the summer were next in order, whereupon,—

THE PRESIDENT, after welcoming the members of the Academy to the beginning of another year's meetings, said that he had travelled but little himself, having been largely in the city, engaged in revising the proofs of his monograph upon fossil fishes, now in course of publication by the U. S. Geological Survey after many years of labor and preparation. This work had prevented him from visiting the Paris Exposition, as he would otherwise have done; and he had only been able to spend a day or two at the American Association's meeting at Toronto.

DR. FRANZ BOAS stated that he had been abroad during the spring and early summer, and had subsequently visited the Pacific coast. In Europe, he had studied methods of instruction in geography, as pursued in the gymnasia of Germany and elsewhere. He had then gone to the west coast of Vancouver's Island, examining the affinities of the native tribes, and thence to the interior portion of British Columbia, also for ethnological researches.

In reply to a question by the President, DR. BOAS stated that the interior of Vancouver's Island was still unsettled by whites, and wholly occupied by the natives; but that the latter were peaceful and under control, so that no dangers, such as formerly existed, are now encountered in travelling there.

MR. BASHFORD DEANE reported upon work carried on under the Fishery Commission, especially in regard to stocking the ponds of Long Island, of which Lake Ronkonkoma is the most important.

He also announced that the great ichthyological collections of the late Mr. J. Carson Brevoort,—long a member of the Academy,—were now being studied and arranged at the American Museum of Natural History.

Vice-President Hubbard reported some interesting geological observations, among them the discovery of a "pot-hole," four feet in diameter and eight feet in depth, at an elevation of 300 feet above the Hudson, opposite Catskill, N. Y. It was exposed by the removal of some 50 feet of loose material (drift), on the country-place of Mr. Frederick Church, the artist, at that point.

Near New Haven, Conn., the Winchester Arms Company have bored for water into the Triassic sandstone. Although only two miles from the metamorphic rocks which bound the sandstone on the west of New Haven, the latter were not reached at a depth of 2,400 feet; at this point the drill broke, still in the sandstone, and the boring was abandoned. No water had been obtained. A similar boring is now in progress at Northampton, Mass.

The President remarked on the extraordinary elevation of the pot-hole described, as indicating a very powerful current at so high a level above the present river, and acting for a very long period.

Prof. D. S. Martin related his visit to the new home of the late Secretary of the Academy, Prof. Fairchild, at Rochester, N. Y., and felt sure that the members would rejoice in hearing of his exceedingly pleasant "environment." He also reported attending the entire session of the Association for the Advancement of Science, at Toronto, where the Academy was represented by a number of its members, and the meeting as a whole was extremely agreeable and interesting.

Dr. N. L. Britton stated that after attending the Toronto meeting, he had made a tour in the northern part of Canada, and found there much interesting matter, both botanical and geological, which he might lay before the Academy at a later day. He also reported work done upon the Academy's library, and upon the herbarium and flora of the State of New Jersey.

He then referred to the recent death of PROF. GEORGE H. COOK, long the head of the Geological Survey of that State, and a Corresponding Member of the Academy, and characterized it as a great loss to American science.

THE PRESIDENT followed in continuance of the same subject, speaking of the great personal sorrow that he felt in the loss of PROFESSOR COOK, of the remarkable modesty, good judgment, and unselfishness that had marked his whole career, of his varied attainments in science, his great services to the geological and agricultural interests of the State, the excellence of his scientific reports and maps as Director of the New Jersey survey, and of his large and unwearied interest in doing good among his fellow-men.

DR. BRITTON having moved the appointment of a Committee to prepare resolutions in memory of Prof. Cook, it was so voted, and the Chair appointed as such Committee, DR. BRITTON, PROF. MARTIN, and DR. BOLTON.

DR. HUBBARD announced the death of one of the Academy's corresponding members, the eminent Italian geologist, PROF. GIUSEPPE MENEGHINI, of Pisa.

The subject of consideration announced for the evening was

THE PROPOSED SITES FOR THE WORLD'S FAIR OF 1892,

with especial reference to the question of the use of any portion of Central Park.

PROF. D. S. MARTIN opened the discussion by saying that it would seem that "eternal vigilance is the price" of maintaining the integrity of our public breathing-places. No sooner is one scheme of invasion or spoliation checked, than some new one arises in its stead. He referred to the movement, some ten years ago, which endangered the existence of Washington Square, when it was proposed to make that the point of emergence of the projected Hudson River tunnel. The Academy at that time had protested vigorously; and the Public Parks Protective Association was organized, and did most excellent work in exposing, denouncing, and ultimately frustrating the attempt. Recently, there has been the project of erecting a great municipal building to occupy the entire northeastern portion of what is still

left of City Hall Park. He spoke of the meeting of citizens at the Mayor's office, two weeks ago, when he had attended and read a protest, in the name of the scientific men of the city, against any such closing-up of that all too limited breathing-spot in the most crowded part of New York. He trusted that the strong and united opposition developed at that meeting, on the part of very various classes of citizens, had served its purpose of staying the proposed movement to occupy that ground. Scarcely is this danger perhaps averted, when the plan is brought forward of occupying the northern end of Central Park in connection with the Exposition. This portion of the Park is peculiarly interesting and attractive because of its comparative wildness and naturalness; it has had less interference by artificial "improvement," so-called, and should therefore be especially guarded from intrusion and injury. He hoped that the Academy would take strong ground in regard to this whole matter.

THE PRESIDENT said that while he sympathized entirely with the views just expressed, he did not think that there was really any danger of the Park's being injured or occupied at all, and that the issue, therefore, was not what the papers had represented it to be. He spoke from personal intercourse with gentlemen active in the World's Fair project, and was satisfied that not a tree in the Park would be felled, or anything allowed to do damage therein. He was much impressed with the difficulties of the work undertaken by the Committee on Sites, and with their conscientious and laborious endeavors to deal with them. Leaving out the question of Central Park, which he did not believe would be touched, the site named by the Committee, —Riverside and Morningside Parks, and the intervening lowlands,—would furnish a location unequalled for beauty of scenery, as compared with any former World's Fair anywhere, and having the great advantage of immediate nearness to the city.

PROF. J. K. REES made some remarks in regard to the eclipse of the sun in December, which will be total on the west coast of Africa, and described the government expedition, now preparing to start in the *Pensacola*, for its observation. He mentioned as of interest to the Academy, that one of its own members, MR. L. H. JACOBY, assistant in the Columbia College Observatory,

had received an appointment on this expedition. PROF. TODD, of Amherst, who addressed the Academy last spring on the results of observations on the eclipse of January 1st of this year, is in charge of the party, and proposes to take out not only astronomical observers, but a number of scientific men eminent in various departments. Among these are such honored names as PROF. CLEVELAND ABBE, in meteorology, PROF. ALEXANDER AGASSIZ, in zoölogy, and others in botany, geology, etc.; so that the expedition promises to be exceedingly rich in scientific results.

The following paper was offered and read by title: it is here presented in full:

NEW OR NOTEWORTHY NORTH AMERICAN PHANEROGAMS, II.[1]

BY N. L. BRITTON.

CALTHA FLABELLIFOLIA, Pursh, Fl. Amer. Sept. ii. 390, t. 17 (1814); Torr. Compend. 224 (1826); Noll, Flora Penn. 8 (1851).

C. palustris, L. var. *flabellifolia*, T. & G., Fl. N. A. i. 27 (1838).

C. palustris, L. var. *Sibirica*, Watson, Bibl. Index, i. 9 in part, (1878), not of Regel.

C. dentata, Muhl. Cat. 55 (1813) ?

This very good species, and exceedingly interesting one, has suffered unmerited exclusion from our American handbooks, probably caused by its limited geographical range and somewhat inaccessible habitat on the higher mountains of Pennsylvania and New Jersey, so that it has been observed *in situ* by very few botanists; all who have actually seen it growing have had but one opinion as to its specific validity. My acquaintance with the plant was first made some five years since on the Shawangunk Mountains in Sussex County, N. J., where I found it growing in a deep swamp near the elevation known as High Point, and collected it in fruit only. In last June, however, through the guidance of Professor Porter, I was introduced to it in its typical locality on the Pocono plateau in Pennsylvania, in which region it was first found by Pursh, and had an opportunity to study the plant in flower. Dr. Porter has long been of the opinion that it is a valid species, and I am glad of an opportu-

[1] The first part of these notes appeared in the *Bulletin of the Torrey Botanical Club*, xv. 97 et seq.

nity to express my belief in the accuracy of his conclusions, based on the same characters as those assigned in the original description.

In the Pocono localities the plant grew actually in the water, in cold mountain springs and brooks, and densely shaded by overhanging bushes. The very different habit of the *C. palustris*, growing in open, sunny swamps, is a fact which does not appear to have yet been recorded.

Mr. Maturin L. Delafield, Jr., has communicated to me specimens of a *Caltha* from West Hampton, Suffolk County, N. Y., which I refer without hesitation to this mountain species. Mr. Delafield has not detected the typical *C. palustris* in the region; and knowing what we now do of the numerous elements in common possessed by the floras of the Shawangunk and Pocono Mountains with those of the coast plains, this is not as remarkable as it might at first appear.[1]

If it should seem desirable in the future to reunite it with the Old World plant which has been known as *C. palustris*, L., var. *Sibirica*, Regel (1861), it is to be remembered that this name is long antedated by *C. radicans*, Forster, Trans. Linn. Soc. viii. 324, t. 17 (1805). But it does not appear to me from the materials now at hand that this will again be suggested. Dr. Gunther Beck, in his review of the relatives of *C. palustris*, in Verhand. K. K. Zool.-Bot. Ver. Wien, xxxvi. 350 (1886), excludes *C. flabellifolia*. In Torrey and Gray's Flora the name is stated to be synonymous with *C. dentata*, of Muhlenberg's Catalogue (1813), but the description there given is not sufficiently explicit, and until the fact can be more conclusively shown I do not consider it safe to take up Muhlenberg's name.

CASTALIA TETRAGONA (Georgi), Lawson, Trans. Roy. Soc. Canada, vi. sec. iv. 112 (1888).

Nymphæa tetragona, Georgi, Reise im Russ. Reichs, i. 220 (1775).

Castalia pygmæa, Salisb. Parad. Lond. t. 68 (1806).

Nymphæa pygmæa, Ait. Hort. Kew. ed. 2, iii. 293 (1811).

This may be announced as a North American plant, having been collected in ponds along the Severn River, Keewatin, Canada, by Mr. Jas. M. Macoun, July 17th, 1886. This locality lies between Hudson's Bay and Lake Winnipeg, in latitude about 55°. It had previously been collected by Mr. R. Bell at Misinaibi River, Ontario (July, 1879). Specimens from both localities are preserved in the herbarium of the Geological and Natural History Survey of Canada. The plant may at once be

[1] Bull. Torr. Bot. Club, xi. 126–128; xiv. 187–189.

distinguished from the eastern *C. odorata* var. *minor*, by its oblong leaves, sometimes nearly twice as long as broad, with narrow, acutish lobes, and the flowers still smaller with 7 to 8 rayed stigma. The identification of the American and Asiatic plants has been made on specimens of *C. pygmæa* from Khasia (Hooker and Thomson) and Japan (Albrecht, 1861). As to the relationship of Dr. Morong's *C. Leibergii* to the present species, I am not yet willing to express a positive opinion. Dr. Morong remarks, in his original description of the plant (Bot. Gazette, xiii. 124), "leaves with a broad, open sinus and obtuse lobes"; but specimens recently received from Mr. Leiberg have the sinus narrow, as in *C. tetragona*, and the lobes quite as acute, the laminæ being of precisely the same outline; this leaves practically nothing but the obtuse petals to distinguish it from the species here discussed. Indeed, some of the inner petals are much the same form as those of *C. tetragona*.

Professor George Lawson has also examined the Canadian specimens here alluded to, and (loc. cit. 113) refers them to *C. odorata* var. *minor*, but I cannot agree with him in this. Curiously enough, in his otherwise exceedingly complete synopsis of the Nymphæaceæ he makes no mention of *C. Leibergii*.

The leaves of *C. tetragona* are of much the same size and form as those of *Nymphæa microphylla*.

CARDAMINE DOUGLASSII (Torr.).

Arabis rhomboidea, Pers. (*bulbosa*, Muhl.), var. *purpurea*, Torr. Amer. Jour. Sci. iv. 66 (1822).

Cardamine rotundifolia, var. *β* Torr. & Gray, Fl. N. A. i. 83 (1838), and *Arabis Douglassii*, Torr., as synonym.

Cardamine rhomboidea, var. *purpurea*, Torr. Fl. N. Y. i. 56 (1843), with the same synonym.

Cardamine bulbosa, var. *purpurea*, B. S. P. Prel. Cat. Anth. N. Y. 4 (1888).

C. rotundifolia, Hook. Fl. Bor.-Amer. i. 44; Wats. Bibl. Index, i. 54, not of Michaux.

After a careful study of this plant in the field and herbarium, I have come to agree with my friends, Judge Day and Professor Macoun, that it is specifically distinct from the white-flowered species with which it has been associated. The specific name adopted appears to be the earliest one available, although it has never, so far as I can make out, been published except as a synonym. Dr. Torrey must have fully intended to print it as *Arabis Douglassii*, and was later under the impression that he had actually done so, for he uses the synonym on page 83 of the "Flora of North America," referring to the place where he published it as *A. rhomboidea*, var. *purpurea* (at least to within

three pages of the actual citation). This mistake has been copied by himself in the "New York Flora," and by Dr. Watson in the "Bibliographical Index," where matters are still further complicated by the erroneous reference of the plant to Michaux's *rotundifolia*, although this has been subsequently corrected by Dr. Gray in Botanical Gazette, iv. 210.

Besides the beautiful purple flowers, which unfold ten days earlier than those of *C. bulbosa*, in the locality near Newfoundland, New Jersey, first noted, I think, by Professor Joseph Schrenk, where I have studied the living plants, the species differ in the root-leaves of *Douglassii* being uniformly more nearly orbicular and the stem-leaves broader and generally more deeply dentate. The texture of the leaves is thicker, and the whole plant lower than *bulbosa*. I have found no essential difference in the fruit.

CARDAMINE FLEXUOSA, With. Bot. Arr. Brit. Plants, Ed. 3, 578 (1796).
C. sylvatica, Link, in Hoffm. Phyt. Blat. i. 60 (1803).
C. Virginica, Michx. Fl. Bor.-Amer. ii. 29 (1803), not of Linnæus.
C. hirsuta, L. var. *Virginica*, Torr. & Gray, Fl. N. A. i. 85 (1838).
C. hirsuta, L. var. *sylvatica*, Gray, Man. Ed. 5, 67 (1867).

I am indebted to Mr. Arthur Bennett, of Croydon, England, than whom no one is better acquainted with the English flora and its literature, for valuable notes respecting this widely distributed species; and I agree with him and with other British botanists that it is distinct from *C. hirsuta*. So far as I have observed, its habitat is on rocky banks in more or less shaded woodlands; that of *C. hirsuta* being either actually in the water or in very moist situations. It appears to be a smaller plant than *C. hirsuta*, with a decidedly flexuous stem, the leaves smaller and with narrower divisions. That our plants have always six stamens as against four in *hirsuta*, as stated in the English floras, I have not yet been able to satisfy myself fully; but in those which I have had opportunity to examine this distinction appears to hold good. I have collected *C. flexuosa* recently on the sides of Mount Mackay, near Port Arthur, north shore of Lake Superior.

POLYGALA VERTICILLATA, L. var. AMBIGUA (Nutt.).
P. ambigua, Nutt. Gen. ii. 89 (1818).

I have failed to separate this as a species, finding no characters which are at all constant, after studying a very extensive series of specimens.

HYPERICUM VIRGATUM, Lam. var. OVALIFOLIUM, n. var. Leaves oval, not more than twice as long as broad, mostly obtuse, and varying to obovate. Pine-barrens of New Jersey.

VITIS HEPTAPHYLLA (Buckley).
Ampelopsis heptaphylla, Buckley, Proc. Phil. Acad. Nat. Sci. 1861, 450.

The suppression of this species by Dr. Gray was, I judge, quite unwarranted; and now, from abundant material, I feel justified in contending for its specific rank, not from the mere fact of its generally developing more than five leaflets (the Virginia Creeper has sometimes seven, as was first noted, I think, by Mr. Meehan), but from other characters which are more constant. Mr. Buckley pleaded forcibly for its recognition nine years later (l. c., 1870, 136), remarking on its smaller leaflets (comparing it with the ordinary Virginia Creeper) and its "cymose panicles," which flower at the end of April, while plants of *V. quinquefolia* in the same locality do not flower until the middle or end of June. Specimens collected by Mr. Tweedy, in 1879, in Tom Greene Co., Texas, maintain the characters assigned by Mr. Buckley; and the collections of Wright, Fendler, Bigelow, Buckley, and this last, indicate a wide range for the vine in western Texas. Young's "Flora of Texas" maintains the species, and the recent monograph of M. Planchon recognizes it as a variety at least, although that author had not seen specimens.

ACER SACCHARUM, Marsh. var. NIGRUM (Michx. f.).
A. nigrum, Michx. f. Arb. Amer. ii. 238.
A. saccharinum, var. *nigrum*, Torr. & Gray, Fl. N. A. i. 248.

The adoption of Marshall's name *saccharum* for the Rock Maple in place of the more recent *saccharinum* of Wangenheim (the *saccharinum* of Linnæus applying to the Silver Maple, as recently remarked by Professor Sargent in "Garden and Forest") renders this readjustment of the varietal name necessary, if, as I contend, it is to be considered a variety, and I have so used it in the new "Flora of New Jersey."

PHASEOLUS UMBELLATUS (Muhl.).
Glycine umbellata, Muhl. in Willd. Sp. Pl. iii. 1058 (1800).
Phaseolus helvolus, Torr. & Gray, Fl. N. A. i. 280 (1838); Gray, Man. Ed. 5, 140, not of Linnæus.

Phaseolus helvolus, L. Sp. Pl. 724 (1753), belongs to the plant which appears in recent writings as *P. diversifolius*, Pers. It is therefore desirable to take up the oldest specific name available, which appears to be that of Muhlenberg.

ASTER LATERIFLORUS (L.).
Solidago lateriflora, L. Sp. Pl. ii. 879 (1753), fide Gray, Syn. Flor. 143 and 187.
Aster diffusus, Ait. Hort. Kew. iii. 205 (1789).
A. miser, Ait. l. c.

SENECIO HALLII, n. sp. Nearest to *S. canus*, Hook. Stems 4–6 inches high, simple; stems, leaves, and scales of the involucre densely and persistently white-woolly all over; leaves about one inch long, spatulate, the blade about equalling the petiole; heads $\frac{1}{4}$ in. high, $\frac{1}{2}$–$\frac{3}{4}$ in. broad, with the rays expanded; rays about a line wide; achenes (immature) about a line high, angular, glabrous.

Yellowstone National Park, on geyserite; collected by the Rev. Dr. Charles H. Hall, of Brooklyn, N. Y., in June, 1888. Dr. Hall collected also the *S. canus*, Hook., in the same region; and it was the great difference in appearance of the two plants that suggested to me a careful comparison of their characters. I fortunately found that a type of Hooker's species was preserved in Dr. Torrey's herbarium, and saw at once that the plant here described was different. I have evidence that it has been collected in other parts of the Rocky Mountain region. It is one of the most beautiful and interesting of the genus, its extraordinary amount of woolly tomentum fully justifying Dr. Hall's exclamation on finding it,—"looks as if it were done up in blankets."

VACCINIUM DISOMORPHUM, Bigel. Fl. Bost. Ed. 2, 151 (1824), not of Michaux.
V. fuscatum, Gray, Man. Ed. I. 262 (1848), not of Aiton, fide Syn. Flor. Gamopet. 23.
V. corymbosum, L. var. *atrococcum*, Gray, Man. Ed. 5, 292 (1867).
V. corymbosum, L. var. *disocarpum*, B. S. P. Prel. Cat. Anth. N. Y. 32 (1888).

Field observations on this shrub, extended over several years, have now convinced me that it is specifically distinct from *V. corymbosum*. Indeed, I have not been able to find any intermediate forms. Its characters were distinctly pointed out by Dr. Bigelow, being essentially the small cylindric corolla of a decidedly pink color, contracted at the throat so as to become somewhat ovate (5 mm. long); the light-colored bark which tends to become shreddy; the tomentose lower leaf surfaces; and the perfectly black berries without bloom. On Staten Island and in the Pocono region, where the two species grow commonly in company, they can always be distinguished at a glance, whether in flower or fruit. I should say that they are quite as distinct as *V. Pennsylvanicum* and *V. Canadense*.

I have adopted Dr. Bigelow's spelling of the specific name, who took it from Richard in Michaux's Flora, but presume that it should be *dissomorphum*, as Dr. Torrey has it on page 446 of the first volume of the "New York Flora," where he appears to have confounded it with *V. Canadense*. Dr. Gray remarks, in the first edition of his "Manual," that the characters of the plant appear to be perfectly constant, but he subsequently changed his mind and in the fifth edition it appears only as a variety. In his "Synoptical Flora" it is given, under *V. corymbosum* var. *atrococcum*, as *V. disocarpum*, and this misprint was taken up in the Torrey Club's Preliminary Catalogue.

LIMNANTHEMUM AQUATICUM (Walt.).
Anonymos aquatica, Walt. Flor. Car. 109 (1788).
Menyanthes trachysperma, Michx. Flor. Bor. Amer. i. 126 (1803).

Mr. A. C. Apgar sends this species from a pond at Bridgeton, Cumberland Co., N. J., thus bringing it within the 100-mile circle of the New York local flora. Mr. A. Commons had previously collected it at Millsboro, Sussex Co., Del., just without the limits of the local flora.

PAULOWNIA TOMENTOSA (Thunb.).
Bignonia tomentosa, Thunb. Flor. Jap. 252 (1784).
Paulownia imperialis, Sieb. and Zucc. Flor. Jap. i. 27, t. 10 (1835).

While hardly deserving notice under this heading, it is of interest to record that this Japanese tree has established itself in rocky woods at Rocky Hill, N. J., where it flowers freely, as observed by Rev. L. H. Lighthipe.

UTRICULARIA CLEISTOGAMA (Gray).

In the fifth edition of Gray's "Manual," page 320, mention is made of the discovery by Mr. J. A. Paine, Jr., in September, 1866, in the pine-barrens of New Jersey, of a few specimens of a minute *Utricularia*, with faint pink-purple corolla not larger than a pin's head. In the "Synoptical Flora," Dr. Gray describes this plant as *U. subulata* var. *cleistogama*, as "an inch or two high, bearing one or two evidently cleistogamous flowers." It was again collected in 1881, in wet ground along Atsion River below Atsion, N. J.,—also in the pine-barrens,—by Prof. J. A. Allen, of New Haven, Conn., who distributed some specimens.

On August 18th of the present year, while botanizing at Forked River, N. J., also a region of cedar swamp and pine-barrens, I collected a number of specimens of a minute *Utricularia* with strictly cleistogamous flowers, answering the description above given by Dr. Gray, and closely resembling Prof. Allen's collections, except that the lower lip of the corolla is yel-

low, and the upper translucent white. There is no spur, and no *U. subulata* could be detected in the vicinity.

My plants certainly represent a species distinct from *U. subulata*, which I name *U. cleistogama*. It cannot be decided at the present time if these are specifically the same as the earlier collections, although I am inclined to consider them such, notwithstanding the difference in color of the flowers.

EPIDENDRUM TAMPENSE, Lindl. Folia Orchid. 12.

This species was described by Lindley from specimens sent him by Dr. Torrey about 1850. In looking over the genus, last summer, with Mr. Rolfe, at Kew, I noticed the original specimen and remarked that the name had not been used in any of our North American books. He assured me, and satisfied me, that it is a distinct species. On returning home, I investigated the *Epidendra* of our herbarium and found the rest of the specimens, marked "*Epidendrum*, Tampa Bay, Florida, Dr. Leavenworth." Dr. Torrey had not written the name upon the herbarium sheet; and, as the part of the "Folia" containing the description was not in his library, it is probable that he was not aware of the publication of the name. The species has since been collected by Curtiss, and distributed as "*Epidendrum venosum*, Lindl." ("North American Plants," No. 2805. Habitat, on trees, Hillsboro River, Florida).

OAKESIA SESSILIFOLIA (L.), S. Wats.; var. (?) NITIDA, n. var.

Differs from *O. sessilifolia* in its smaller leaves, which are rough-margined after the manner of *O. puberula*, and shining on both sides. Collected by myself, May 30th and 31st, 1887, at Tom's River and Cedar Bridge, Ocean Co., N. J., on the borders of swamps in the pine-barrens. The leaves of *O. sessilifolia*, so far as I have seen them, are always markedly glaucous beneath and dull green above. The young capsules of the new variety are on peduncles 10 mm. long, the corolla and mature capsule not seen. Dr. Watson describes (Proc. Amer. Acad. xiv. 269) the capsules of *O. puberula* as sessile or nearly so; but this is evidently a slip of the pen, for specimens labelled by him in the Torrey herbarium bear capsules on stalks 1 and 2 cm. long.

CYPERUS BUCKLEYI, Britt. Bull. Torr. Bot. Club, xi. 86 (1884).

This species, originally described from the Valley of the Lower Rio Grande, has since been found by Mr. Pringle on hills near Chihuahua (1040), and in the Sierra Madre (1167), and by the same collector in the Santa Rita Mountains, Arizona. Fred. Müller's No. 1989 from Orizaba, and Bourgeau's No. 432 from Pedregal, near Mexico, appear to be the same.

CYPERUS LÆVIGATUS, L., has recently been collected in South Carolina by Mr. Gerald McCarthy—the first evidence we have had of its occurrence on the east coast.

SCIRPUS ATROVIRENS, Muhl. var. PALLIDUS, n. var.

Whole plant pale, including the inflorescence, which is composed of larger heads than in the type, and is more contracted; glumes more squarrose. A well-marked variety, but I am so far unable to detect further differences. The achenium is exactly like that of the eastern plant. Indian Territory (E. Palmer, No. 358, 1868); Mitchell Co., Kansas (M. A. Carleton, 1886); Hitchcock Co., Neb. (H. J. Webber, 1888).

SCHŒNUS NIGRICANS, L., which we have had as North American from Florida only, comes now from the San Bernardino Mountains, southern California, where it was collected in June, 1887, by Mr. S. B. Parish (No. 2058).

HOMALOCENCHRUS, Mieg. Hall. Stirp. Helv. ii. 201 (1768), plainly antedates *Leersia*, Sw. Nov. Gen. et Sp. Pl. 21 (1788), —which is one reason why the latter should not be used, while another is that *Leersia*, Hedw. Fund. Musc. ii. 88 (1782) (*Encalypta*, Schreb.), a genus of Musci, is also older, containing those mosses which have recently been referred back to *Leersia* (Braithwaite, British Moss Flora, i. 279).

Our northern species must receive binomials as follows:

HOMALOCENCHRUS ORYZOIDES (L.), Poll. Enum. Pl. Palat. (1776) = *Leersia oryzoides*, Sw.

HOMALOCENCHRUS VIRGINICA (Willd.)=*Leersia Virginica*, Willd. Sp. Plant. i. 325 (1797).

PANICUM NITIDUM, Lam. var. PAUCIFLORUM (Vasey).

P. dichotomum, var. *pauciflorum*, Vasey in Columbia College Herbarium.

This is a very slender, smooth grass, with a simple panicle of five to ten divaricate branches, and these again very sparingly divided and filiform, the whole number of flowers on any single panicle not exceeding twenty. The flowers are larger than in ordinary forms of either *dichotomum* or *nitidum*, the stem-leaves linear, acuminate, distant, about 5 cm. long, the radical short and ovate.

Collected by myself on a mountain east of Lake Hopatcong, Morris Co., New Jersey, July, 1884.

PANICUM NITIDUM, Lam. var. VIRIDE (Vasey).

P. dichotomum, L. var. *viride*, Vasey, Bull. 8, Bot. Div. U. S. Dept. Agric. p. 30 (1889).

I think this a very well-marked woodland variety, but should

refer it to *P. nitidum* rather than to *P. dichotomum*. I have observed and collected it frequently in the highlands of New Jersey.

October 14, 1889.

STATED MEETING.

VICE-PRESIDENT TROWBRIDGE in the chair.

Nine persons present (the evening being very stormy).

The following paper was read by title:—

A REVIEW OF THE AMERICAN SPECIES OF THREAD-FINS (POLYNEMIDÆ).

BY MR. PHILIP H. KIRSCH.

It will appear in the ANNALS, Vol. V.

The paper of the evening was then read, as announced:—

THE ORIGIN OF DIAGONAL TRENDS IN THE EARTH'S CRUST, WITH APPLICATION TO THE PRODUCTION OF NORMAL AND REVERSED FAULTS AND THE FOLDING OF STRATA.

BY PROF. DANIEL S. MARTIN.

(Abstract.)

In studying the processes of evolution by which our globe has assumed its present form and structure, notwithstanding all that has already been traced out, there remain vast and varied fields of investigation that have thus far baffled the acutest reasoning and eluded the most laborious search. Especially is this the case with all those problems which concern the interior of our planet, or the lower portions of its crust. What processes are there going on at the present time, or have taken place in the distant past, it is of course peculiarly difficult to ascertain, partly from the inaccessibility of the region, and partly because the conditions there existing are so widely different from those at and near the surface, where alone observation is possible. Yet so important and so intricate are the relations which connect the interior with the exterior of the globe, that the subject forces itself upon us in any attempt to study the history and structure of the earth. At the same time, and for the reasons already referred to, it is a subject that affords peculiar scope for specula-

tion, and hence is a favorite realm for the geological theorist, where the processes evolved from his inner consciousness are safe from the rigorous tests of observation.

On these accounts, the suggestions of this paper are presented only after much hesitation, and solely as a contribution to the general discussion of the subject, as indicating certain lines of inquiry and observation by which their ultimate value may be proved or disproved.

Certain great facts in the process of world-building stand out undisputed and unchanged, while our theories as to their origin are constantly varying, and, we may hope, advancing nearer to the truth. [Various points of recent discussion were cited here in illustration.]

There is one remarkable body of facts, to which but little attention has been given by geologists, and for which, so far as I am aware, no cause has been clearly assigned. Yet the facts are so striking and important that this omission seems singular, amid all the theories and discussions of crust-structure. I refer to the system of diagonal trends which is so marked in the geography of the globe.

The fact has been long observed, and often alluded to by physical geographers, that the continents and islands are largely adjusted upon two great systems of lines having a general N.E.–S.W., and N.W.–S.E. direction respectively. Prof. Dana devotes to this subject a brief but very interesting and suggestive chapter in the opening portion of his "Manual of Geology." But, in general, the fact has been merely referred to, and no cause recognized or proposed for its origin.

If it be true, however, that there is such a principle of structure underlying and determining the form and disposition of the land-masses, we are confronted with a fact of the widest and most important significance, and one that may well challenge attention and inquiry.

As to the form and distribution of the land-areas, we know of course that the continents are growths,—that they have had a history in which, as in other histories, each stage of development is the outcome of previous conditions, and that so their existing form and structure have resulted from features very early outlined. [This subject was treated of briefly, with particular reference to the recent paper of Prof. Dana before the American Geological Society, at Toronto, reaffirming his general doctrine on these points.] Prof. Dana has given us the term *protaxis*, as a happy designation for those early lines of uplift which have determined the subsequent growth of mountain-systems, and by these again the shaping of continental masses.

But the problem of the origin of diagonal trends goes further

back than this. Given a system of protaxial lines, and the growth of the continent will follow and conform to them. Of course, countless modifications will arise, and interfere with any mathematical regularity of form; apart from these, however, the great facts are as stated. But what laws or forces have, in the early stages of crust-growth, given direction to these diagonal protaxes? This is the problem for which I venture to suggest a solution.

Much has been said and written about strains in the crust arising from various sources. Mr. T. Mellard Reade, *e. g.*, has laid great stress upon difference of temperature between the outer and the inner portions of the crust, regarding the latter as tending to expand by heat, while held in compression from without by the cooler and contracting envelope of the super-crust. The more general view has regarded the entire crust proper as tending to contract irregularly upon the shrinking interior mass. But whatever our view as to the process of deformation by the elevation and depression of portions of the surface, we are brought back to the same question as to the origin of these diagonal lines, to which the irregularities of crust-level have so largely tended to conform.

I desire to call attention, at least as a subject worthy of inquiry, to the horizontal strains resulting from the differential velocities in the rotation of the earth's crust. From an eastward velocity of zero at the poles, to that of a thousand miles an hour at the equator, the actual speed of rotation increases at a rate which, were the earth a perfect sphere, would vary as the cosine of the angle of latitude. The centrifugal or inertial force due to this increasing velocity, will vary as the square of the actual rate of motion, and has by some been regarded as competent of itself to produce the present amount of polar flattening, even in the earth's existing condition, and apart from a former supposed fluidity of the mass. The full discussion of these topics, however, belongs to mathematical physics, and cannot be entered upon here, at least for any quantitative estimates. All that is attempted in this paper is to point out the tendency of these differential velocities to produce in the crust a series of strains, which would of necessity take diagonal courses such as those referred to.

In illustration of this view, I recall for comparison the phenomena observed in the ice of moving glaciers, as expounded by Tyndall and other leading glaciologists. The formation of two intersecting systems, diagonal to the glacier and at right angles to each other,—one of ridges and one of crevasses,—is of course familiar to all present, as resulting from the difference of velocity between the central and the marginal regions. A "shearing"

motion is thus produced, which causes in the one direction fracture by extension, and in the other ridging by compression.

I suggest, therefore, that as soon as a continuous crust began to form over the globe, there must have been a constant tendency to the production of a system of fractures and a system of ridges, the former trending in a general way parallel to the direction of the trade-winds, and the latter intersecting them at right angles. This phraseology is used, as briefly expressing the courses that must otherwise be described in much more extended wording, unless we adopt special terms for the purpose.

The latter course is probably the best, however, as the comparison with the trade-winds is liable to confusion. I will therefore propose the term Eoclinal to denote the courses inclining toward the east in passing from the poles toward the equator, and Hesperoclinal for those inclining toward the west, equatorward,—or, as I expressed it, lying parallel to the course of the trade-winds.

The increasing eastward velocity of rotation in the lower latitudes will, I claim, place the crust in a condition of twofold horizontal strain, and tend to develop a series of eoclinal ridges of compression and hesperoclinal lines of extension, fracture, and igneous outflow. By such a process, acting in the earliest periods of crust-formation, I suggest that a double system of diagonal trends would have been produced, determining the general course of those primal or protaxial lines on which, by a long succession of subsequent movements, the land and water areas of the globe have been shaped.

It will, of course, be objected to this view, that there is no such uniformity and simplicity in the character and distribution of fold-systems and fault-systems as would result from the process thus suggested. This objection would be valid if the theory asserted that such is the mode of formation of the present features of geographical and geological structure; but it regards the latter only as secondary and derivative—in many cases remotely derivative—from very ancient systems of disturbance and displacement, of which the direct evidences and results have long since been obscured, modified, or removed.

I would here suggest, as extremely desirable, a much more careful and minute attention than has heretofore been given, to the detailed structure of the earliest lines of uplift and faulting that are known to us. It may indeed be that even these will fail to confirm strongly the view here presented, which would then become purely theoretical and incapable of absolute proof or disproof. In this respect, however, it would be no worse than many theories propounded and advocated by much more accomplished geologists.

There are several points related further to the views of this paper, which may here be briefly presented.

(I.) As to the origin and structure of faults.—Prof. LeConte has recently announced, before the Society of American Geologists, a theory as to the origin of normal faults,—a theory which is ingenious, but not to my mind wholly satisfactory. He conceives an upswelling of the crust over a large area, and the ultimate fracture of it into a number of blocks or pieces having a rhomboidal vertical section. The fracturing allows the escape of igneous or gaseous matter, which by its accumulation or "intumescence" has caused the elevation of the region. The blocks then settle down somewhat irregularly, tending by gravity to tip in such a manner as to bring about the position found in normal faults, *i.e.*, with "the hade toward the downthrow." The view is ingenious and simple; but it seems as though the process would be subject to so many complications that it could scarcely result in a general law, especially in the presence of the tendency to compression and contraction in the crust, which would be apt to produce an opposite result.

But if faults arise in the manner of marginal crevasses, *i.e.*, by rupture across lines of permanent crust-tension, it is plain that the law of normal faulting must follow of necessity. Reversed faults and normal faults may then appear as the consequence respectively of compression and of extension. The course of the former should (*originally*) have been eoclinal, and of the latter hesperoclinal. The association of reversed faults with folded strata is already well known, and indeed seems inevitable. Where faulting has occurred in overturn folds, caused by lateral thrust, the hanging wall must properly override the foot-wall,—the latter having the downthrow and the former the upthrow. In this case, the readjustment of parts is such as to show actual horizontal compression, as in the folds and overturns associated with it. But in the case of a normal fault, the readjustment is one of horizontal extension, and would certainly indicate as its cause a stretching rather than a crushing force.

(II.) The earth's velocity of rotation has thus far been referred to as though constant in rate. If, on the other hand, as generally believed, it has been subject to any variation in the past, important results must follow as to the horizontal strains. In the process of contraction, the reduction of volume would naturally produce increased rapidity of rotation, from the tendency to the persistence of inertial velocity. If so, the result would be to maintain and intensify the action already suggested. If, on the other hand, by tidal friction or lunar retardation, the rate of axial rotation has tended to diminish, any balance already established in the strains of the crust would be disar-

ranged, and a reverse process would set in. It is interesting to observe that in the case of a mountain system like the Appalachians (hesperoclinal),—so conspicuously formed through long periods by a lateral pressure from the southeast,—the structure is precisely such as would result from a repeated or long-continued reduction in the eastward velocity of the earth's rotation. These points are referred to, partly to show how complicated may be the actions and interactions of forces involved, and partly as indicating a method by which it may be possible to determine whether the earth's axial motion has been gaining or losing in rate through the geological ages.

(III.) Of course, as already noted, the *differences* of velocity vary greatly according to distance from the equator,—the velocities themselves having the ratio nearly of the cosines of the latitude-angles. It follows, therefore, that any such action as that here suggested, depending upon the differential velocities, must vary correspondingly, both in direction and amount. The effects should be greater, and the courses more east-and-west, as we pass from the equator poleward. The fact that the earliest areas of elevation are so largely found in the higher northern latitudes, is of interest, and perhaps of importance, in this view. According to the theory, it is in the high latitudes of both hemispheres that the action should be most observable; and as we pass from the poles toward the equator, it should be more obscured, complicated, or replaced by later and secondary processes. The far southern regions are of course practically inaccessible under their mantle of sea and ice, and only the northern areas are at all open to study.

(IV.) If the careful and extended collection and comparison of facts should be found to establish the views of this paper, another important question may thereby be helped toward a solution. I refer to the permanence of direction of the earth's axis, whether by this is meant its absolute direction in space or its relative direction to the surface of the globe. Any disturbance or variation, especially of the latter, must result in great disarrangement of the horizontal strains, and express itself in new systems of stress and displacement, which would indicate both its direction and its amount.

I have been able here only to touch upon this extensive subject, and to suggest some of the results that may flow from its fuller prosecution. The theory is presented, however, though in brief and imperfect form, as a matter for reflection, observation, and inquiry.

The paper was illustrated with diagrams of faults, crevasses, and diagonal trends on the globe.

Prof. Trowbridge made some remarks upon the paper, expressing his interest in the views presented, and stating that he could see no objection to their validity on mechanical grounds, and that he regarded the solution as a very rational one for the facts as described.

Mr. John Patten spoke of his observations upon the occurrence of faults of both the kinds alluded to in the article, while engaged in mining operations on the Pacific coast.

Prof. Martin made some additional remarks, alluding therein to a criticism that had been made on his view, to the effect that a balance would soon be arrived at in a rotating globe, and that then all the parts would move together "as naturally as those of a wheel." That the differential velocities in such cases do produce strains, which are at times sufficient to overcome cohesion, is perfectly familiar in the examples afforded by the occasional violent disruption or "bursting" of millstones and fly-wheels. Usually, the force of cohesion is adequate to prevent such effects; but it by no means follows that there are no strains because all the parts are compelled thus to move in apparent accordance. In the case of the earth, where the crust is not so rigid, the effects would be slow and gradual, instead of sudden and violent.

October 21, 1889.

Stated Meeting.

The President, Dr. Newberry, in the chair.

Ninety-five persons present.

The paper announced for the evening was then read, and largely illustrated with lantern views; it was entitled

RESEARCHES ON SONOROUS SAND IN THE PENINSULA OF SINAI.

BY H. CARRINGTON BOLTON.

(Abstract.)

This paper was in continuation of others presented to the Academy by the author and Dr. Alexis A. Julien, on May 14th, 1883, March 10th, 1884, April 28th, 1884, October 15th,

1888, and May 13th, 1889. In these papers the occurrence of sonorous sand on beaches in America and Europe, its physical properties, and the acoustic phenomena characteristic of it, were detailed. In the present communication, DR. BOLTON reported the result of a personal investigation of the sonorous sand in the Desert of Arabia Petræa, especially at Jebel Nagous on the Gulf of Suez.

After describing the proximate starting-point for Jebel Nagous, the little village of Tor, and the surface geology of the vicinity, the speaker detailed his experiences at the "Mountain of the Bell," so-called. This mountain is situated about 4½ hours N. W. of Tor, on the Gulf of Suez. On its steep sides rest several large banks of sand ; one of these, which I distinguish by the name Seetzen's Bell Slope, after its discoverer, emits distinct musical sounds whenever the sand slides down the incline, either spontaneously or through the agency of man. The mountain consists of massive white sandstone carrying quartz pebbles and veins ; it is about three miles long and 1,200 feet high. The huge Bell Slope measures 260 feet across the base, 5 or 6 feet across the top, and is 390 feet high ; it is bounded by nearly vertical walls of sandstone. The sand rests on the rocks at the high angle of 31°, and is very fine-grained, yellowish-white, and composed chiefly of quartz and calcareous sandstone. The grains are well rounded to subangular, and silt is notably absent. As the sand reposes at a high angle, it possesses a curious mobility which causes it to flow down the incline like soft pitch or molasses ; the sand above the point of disturbance falls into the depression, and thus the depression advances up the slope at the same time. This downward flow takes place spontaneously whenever the sand, forced up the incline by the violent winds, accumulates in such quantity as to exceed the angle of rest. The movement is accompanied by a strong vibration and by a musical tone resembling the lowest bass note of an organ with a tremolo stop. The larger the bulk of sand moved, the louder the sound ; it is by no means so sensitive as the sand of so-called singing beaches, and fails to emit sounds when struck with the hand or clapped together in a bag. The vertical cliffs on either side yield an echo which may magnify and prolong the sounds, which were loud enough to be heard for several hundred feet. The peak of Jebel Nagous rises above the Slope to the height of 955 feet above the sea-level.

The sand of the Slope is derived partly from disintegration of the rock itself, and partly from the more distant plain below, from which violent winds blow it up on to the mountain side.

The Bedouins of the region account for the acoustic phenomenon by attributing it to the *Nagous*, or wooden gong of a subter-

ranean monastery in the heart of the mountain, and claim that the sounds can only be heard at the hours of prayer.

Several other sand-banks, presenting a similar appearance to the eye, were tested, but gave out no musical sounds whatever. Microscopical examination of the sand shows that it contains much silt, which prevents the vibrations necessary to yield the sounds. After careful study, however, of Seetzen's Bell Slope, I became convinced that the phenomena could not be unique in the desert, as supposed; and hence I made systematic search for another locality. After testing many sand-banks on the journey northward to Suez, I discovered, on April 6th, banks of sonorous sand resting on low cliffs a quarter of a mile long. This new locality is in Wadi Werdân, about a day and a half from Suez by camels, and is on hillocks called Ojrat Ramadân.

The sand blown from the extensive plains to the north falls over the southern face and rests at two angles, 31° at the top and 21° or less near the base. Wherever it possesses the mobility before described, it emits a distinct musical note on being disturbed. The highest bank measures only sixty feet on the incline, and it is not probable that the sounds can occur spontaneously. Dr. Julien has named the new locality Bolton's Bell Slope, and reports that microscopical examination shows the sand to consist chiefly of quartz grains, and a larger proportion of calcareous sandstone than at Jebel Nagous. The size of the grains of quartz varies from 0.11 to 0.42 mm. and of sandstone 0.11 to 0.34 mm.,—the average being smaller than that of the sand-grains on Jebel Nagous. Like the latter, it is very free from silt.

Various hypotheses have been proposed to explain the cause of the sonorous property in certain sands. Sir James Prinsep, Secretary of the Asiatic Society of Calcutta, attributes the sound produced at Jebel Nagous to a "reduplication of impulses setting air in vibration in a focus of echo."

Hugh Miller, after his visit to the singing beach at Eigg, interested his friend, Sir David Brewster, in the problem, and he wrote of "accumulated vibrations of the air when struck by the driven sand, or the accumulated sounds occasioned by the mutual impact of the particles against each other." The sonorousness of the sand at Kauai has been attributed to the cellular character of the coralline material; that of Jebel Nagous to its essentially quartzose nature; that of the Baltic coast of Prussia to the saline crust on the beach (Dr. Berendt); but the researches of Dr. Julien and myself show that the sonorous property is independent of material and of saline waters. Many other explanations have been offered, which we can here but briefly name:—electricity; effervescence of air between moistened grains; solari-

zation; and reverberation within subterranean cavities. Charles Didier, when travelling in Arabia, heard of the acoustic phenomena at Jebel Nagous, and, although he did not visit the place, promptly offers to explain it by attributing the sounds to "interior cataracts or a subterranean volcano."

Mr. Carus-Wilson, of Bournemouth, England, explains the sonorousness of sand on a beach as follows:—"The music from sand is simply the result of the *rubbing together* of the surfaces of millions of perfectly clean grains of quartz free from angularities, roughness, or adherent matter in the form of clinging fragments investing the grains, and these microlithic emissions of sound, though individually inaudible, might in combination produce a note sufficiently powerful to be sensible to us" (Lecture of November 2d, 1888).

Without attempting to analyze or criticise the above theories, all of which we believe to be wholly inadequate, we briefly repeat our own.

Dr. Julien and I believe that the true cause of sonorousness in the sands of singing beaches and of deserts is connected with thin pellicles or films of air, or of gases thence derived, deposited and condensed upon the surface of the sand-grains during gradual evaporation after wetting by seas and lakes or by rains. By virtue of these films, the sand-grains become separated by elastic cushions of condensed gases, capable of considerable vibration, and whose thickness we have approximately determined. The extent of the vibration and the volume and pitch of the sound thereby produced, after any quick disturbance of the sand, we also find to be largely dependent upon the forms, structures, and surfaces of the sand-grains, and especially upon their purity or freedom from fine silt or dust.

Though the environment of the sand on beaches and in the desert differs greatly as respects moisture, we believe that the above theory is applicable to both. Statistics of rainfall in the desert are wanting; but the experiences of travellers, and my own observations, show that rain falls in the winter months abundantly in many parts of the peninsula. In the vicinity of Mount Sinai, heavy snows and rain are precipitated in December and January, occasionally causing veritable floods in narrow valleys, as experienced by Capt. Palmer; I noted a ten-hours' shower in Wadi Feiran in March (1889), and I saw raindrop impressions on mud-flakes at several points on the coast. Water, therefore, is not wholly lacking to aid in the chemical cleansing of the sand-grains, and the powerful winds accomplish the work of sorting and winnowing done by the waves elsewhere. The fineness of the grains at the Bell Slopes makes the displacement of a very large amount of sand necessary for the production of

sound, while the coarser particles on the beaches yield a resonance on smaller provocation.

We have elsewhere (Proceedings Am. Assoc. Adv. Science, 1883 and 1884) shown that the pitch of the musical notes produced on sea-beaches is directly proportional to the mass of sand moved,—the greater the mass the lower the tone; on the Bell Slopes in the desert the large mass moved yields a very deep note.

The lantern illustrations,—all from photographs recently taken by DR. BOLTON,—comprised, besides a map of the region, views of Tor and its vicinity; the scenery along the desert route and on the shore of the Red Sea; the Jebel Nagous range, and the Bell Slope itself; the new slope of the Ojrat Ramadân; and reproductions of two drawings previously published by travellers (one English and one American), purporting to represent the slope of Jebel Nagous, but extraordinarily inaccurate and misleading, and widely different from each other!

October 28, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Sixty persons present.

THE PRESIDENT made a reference to a very remarkable series of discoveries in palæontology recently made by PROF. O. C. MARSH, of Yale College, in the Judith River beds of the Laramie group. He had enjoyed the opportunity of examining some of the material brought on by Prof. Marsh, and it was certainly of unusual interest. The most striking remains are those of gigantic saurians, which present an extraordinary combination of characters,—skulls measuring seven feet in length, and bearing a pair of laterally projecting horn-cores, that must have supported horns much like those of Bovidæ, though enormous in size. The jaws are beaked after the manner of tortoises, and also armed with downward-pointing teeth or tusks from the back part of the upper mandible; while the head behind is extended into a sort of collar of bony spikes, directed backward, and

recalling on a gigantic scale the points of the head in the "horned toads" (Phrynosoma). These novel and singular forms are to be described by Prof. Marsh in the forthcoming number of the *American Journal of Science.*

DR. N. L. BRITTON then gave the paper announced for the evening, which consisted of an illustrated lecture on

FERNS AND THEIR ALLIES, PRESENT AND PAST.

The lecture treated of the Acrogen plants in their several divisions,—Filices, Equiseta, and Lycopodia, together with the Rhizocarpeæ, Isoeteæ, and Selaginellæ. The latter were spoken of as now separated from the Lycopodia, with which they had long been classed, by the possession of two distinct kinds of sporangia, bearing ♂ and ♀ spores respectively, and thereby presenting a more advanced type than the Lycopods. The fertilization of ferns, etc., and the obscurity in which it was long involved, were described and illustrated, and reference made to the various old fancies and tales about the powers and properties of "fern-seed." The related fossil forms, Lepidodendron, Sigillaria, etc., were then alluded to and illustrated.

November 4, 1889.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-five persons present.

The Report of the Council was read, recommending

(I.) The payment of bills as follows:—

Publication of TRANSACTIONS, Vol. VIII., Nos. 7 and 8, . .	$223.24.
Various minor expenses, . .	43.37.

(II.) The appropriation of a sum not exceeding $100.00, to be placed at the disposal of the Committee on Lectures, for expenses incident to their work.

(III.) The election of the following persons as Honorary Members of the Academy:—

M. Charles Barrois, of Lille, France.
Prof. Asaph Hall, of Washington, D. C.
Prof. Wolcott Gibbs, of Newport, R. I.
Prof. George L. Goodale, of Cambridge, Mass.

(IV.) The election as Resident Members of

Mr. Jasper E. Corning.
Lieut. W. W. Gibson.
Mr. William Niven.

(V.) The transfer of Mr. Frederick Schack from a Resident to a Corresponding Member, in consequence of removal to the West.

The several recommendations were approved by vote of the Academy, and the gentlemen named elected as specified.

The paper of the evening was then read, as follows:—

THE LARAMIE GROUP,—ITS GEOLOGICAL RELATIONS, ITS ECONOMIC IMPORTANCE, AND ITS FAUNA AND FLORA.

BY J. S. NEWBERRY.

The term Laramie Group was first used by Mr. Clarence King, who applied it to a series of sandstones and shales containing beds of coal exposed at Point of Rocks, Black Butte, and other places along the line of the Union Pacific Railroad, and having great development in Colorado and Wyoming. Mr. King considered this the uppermost member of the Cretaceous system, and excluded from it the Fort Union beds of Hayden, which, on the evidence I furnished him, he agreed with me in considering Tertiary. I called the Fort Union group Miocene because I identified it with the plant-bearing beds of Mackenzie's River, Disco Island, Greenland, etc., of which the flora had been studied by Prof. Oswald Heer and was by him called Miocene. This flora, to which I shall again refer, has since been shown by Mr. J. Starkie Gardner to be Eocene. The Fort Union flora has many species in common with the Eocene beds of the Island of Mull, Bournemouth, etc., and holds undoubtedly the same geological position. Dr. Hayden accepted the term Laramie Group, but made it include his Fort Union beds, in which Mr. King did not agree with him, as will be seen in the full discussion of the ques-

tion contained in the Report of the Exploration of the Fortieth Parallel, Vol. I., "Systematic Geology," p. 348 et seq.

Since the publication of Mr. King's report in 1878, much has been written upon the Laramie group by Dr. Hayden, Mr. Leo Lesquereux, Dr. C. A. White, Prof. J. J. Stevenson, Prof. L. F. Ward, and myself. The Tertiary character of the Fort Union flora was recognized by all; whereas the vertebrates and mollusks of the true Laramie of King (the Lower Laramie of Hayden) are so distinctly Cretaceous in their affinities that the Laramie came to be considered by most, as it was asserted by some, to be a formation intermediate in age between Cretaceous and Tertiary. Hayden in his later reports and maps designated it as Post-Cretaceous.

Much undeserved discredit has also fallen upon the remains of plants, as criteria of the age of strata, and much mischief and confusion have followed the error of Dr. Hayden in uniting with the Laramie the totally distinct and independent Fort Union formation.

Prof. E. D. Cope, in the concluding paragraphs of his discussion of the age of the Laramie and Fort Union groups,[1] supposing them to be parts of one formation, says: "I have alluded but cursorily to the opinions of Mr. Lesquereux and Dr. Newberry as based upon the study of the extinct flora. The former has, as is well known, pronounced this whole series of formations to be of Tertiary age and some of the beds as high as Miocene. The material on which this determination is based is abundant and must be accepted as demonstrated beyond all doubt. I regard the evidence derived from the mollusks in the lower beds, and the vertebrates in the higher, as equally conclusive that the beds are of Cretaceous age. There is then no alternative but to accept the result *that a Tertiary flora was contemporaneous with a Cretaceous fauna*, establishing an uninterrupted succession of life across what is generally regarded as one of the greatest breaks in geologic time. The circumstance of the discovery of a Mesozoic Dinosaur, *Agathaumas sylvestre*, with the cavities between its bones stuffed full of leaves of Eocene plants, would prove this proposition to be true had no other fossils of either kind ever been discovered elsewhere."

The locality where the bones and leaves referred to above were found is Black Butte Station, and the horizon the Laramie formation near its base. If Prof. Cope had not accepted Mr. Lesquereux's conclusion in regard to the age of the deposit, and had recognized the fact that there are no Tertiary plants in the true Laramie, he would have seen that there is no discrepancy

[1] "Geological Survey of the Territories," Vol. II., p. 40.

between the testimony of the plant and animal remains, and would have refrained from making the statement quoted above, which has done much to produce and prolong confusion in the minds of geologists, where none exists in the geological record.

Dr. Hayden primarily considered all of his Laramie (Laramie and Fort Union) as Tertiary, but his latest conclusion was that the whole mass was of a transitional character,—beds of passage between the Cretaceous and Tertiary. It is easy to see that this result was inevitable, after he had united an Upper Cretaceous with a Tertiary formation under one name. The typical localities and representatives of the Laramie group are, according to Dr. Hayden, as follows:—1, Placer Mt., N. M.; 2, Cañon City, Colo.; 3, Fort Union or Lignite group, Dakota, Montana, and Wyoming; 4, Bitter Creek series, Wyoming; 5, Bear River group, western Wyoming; 6, the Judith River beds, Montana, which he provisionally placed below the Fort Union series, but considered their age doubtful.

Of the strata exposed in these localities, Nos. 1, 2, 4, 5, and 6 are now known to be Lower Laramie and Cretaceous; while the Fort Union group has nothing in common with these, and, as will be shown further on, has been proved to be Eocene.

Of the Judith River and Fort Union beds, Mr. Meek, as early as 1872, says (Hayden's Annual Report, p. 460):—"That the Judith River beds may be Cretaceous, I am, in the light of all now known in this region of the continent, rather inclined to believe; but it would take strong evidence to convince me, that the higher fresh-water Laramie series [Fort Union] of the Upper Missouri is more ancient than the Lower Eocene. That they are not is certainly strongly indicated by the modern affinities of their molluscan remains, and also by the state of preservation of the latter."

Mr. Leo Lesquereux, in the annual reports of Dr. Hayden, by whom he was employed for many years, and especially in his "Tertiary Flora,"[1] has written much in regard to the Fort Union and Laramie groups. In the introduction to the latter work, he discusses the Lignite formation of North America at length, and treats, first, of the "areal distribution"; second, "stratigraphy and capacity of combustible mineral," and third, "its age indicated by its geological distribution and its fauna." In this comprehensive paper he summarizes the observations made by himself and others; and Dr. Hayden claims, in his letter of transmission, that he settles the question of the age of the Lignitic group, which he regards as one and indivisible, and proves it to be all Tertiary.

[1] Report of the Geological Survey of the Territories, Vol. VII.

Mr. Lesquereux divides his Eocene-Tertiary into four groups, as follows: Group 1: Raton Mts., "Placiere" [should be Placer Mt.], Cañon City, Golden, Marshall's, Erie, Sand Creek, Henry's Fork, Fort Ellis, Spring Cañon, Black Buttes, Alkali Station, Point of Rocks, etc.

Group 2: Evanston, Mt. Brosse, Troublesome Creek, Bridger's Pass.

Group 3: Carbon, Rock Creek, Washakie, Medicine Bow, Fort Fetterman.

Group 4: Barrell Springs, Green River Station, Sage Creek, Florissant, Castello's Ranch, Elko.[1]

The Fort Union beds he places above all the preceding and calls them Miocene, for the same reason that I did, viz., because he identified the flora with that called Miocene by Heer.

Prof. Lester F. Ward, who is now in charge of the department of fossil botany in the U. S. Geological Survey, and whose ability and conscientiousness give special importance to all he writes, has recently published "A Synopsis of the Flora of the Laramie Group." He accepts the erroneous view of Dr. Hayden, that the Laramie and Fort Union groups are parts of one formation, and this colors, and to a degree impairs, the value of his work. He publishes figures of a large number of new species of fossil plants collected by himself, mostly from the Yellowstone Valley. To these he adds a few figures of true Laramie plants which were obtained at Black Buttes, Point of Rocks, Golden, etc.; but his monograph as a whole is simply an important contribution to what was before known of the Fort Union flora.

Among about one hundred species of fossil plants which he figures from Montana, only one is found in the true Laramie; this is *Trapa microphylla*, described by Mr. Lesquereux from specimens obtained at Point of Rocks. Possibly the species may not be the same, for Mr. Lesquereux's material was very meagre; but probably it is the same and comes from the true Laramie beneath the Fort Union beds. If it is the Laramie plant, and found in the Fort Union strata, it will be the first species common to the Laramie and Fort Union floras that has come to my knowledge in twenty years' study of these floras. Even should one or several species of plants be found common to the Laramie and Fort Union beds, this fact would not impair the truth of the statement that I have made, that the Laramie and Fort Union floras are radically distinct and should never be classed together.

Whether the Laramie is Cretaceous and the Fort Union

[1] Recent investigations have shown that this classification requires important modifications.

Tertiary are other questions, but they are certainly distinct from each other,—distinct in the general botanical facies of their floras as well as in the absence of common species. That the Fort Union flora is Tertiary, there can be no reasonable doubt; it has many species in common with the recognized Tertiary in the Canadian provinces of North America, in Greenland, and in the British Islands, and it contains some plants which are living at the present day, such as *Onoclea sensibilis, Taxodium distichum, Corylus Americana, C. rostrata,* etc. Moreover, the grouping of the plants composing it gives it a facies which enables one to recognize it at a glance. The abundance of species and specimens of *Populus, Viburnum,* and *Corylus* imparts to it an aspect as different from that of the flora of the Laramie as are the recent floras of Europe and America from each other.

My reasons for considering the Laramie the upper member of the Cretaceous are these:—1st. It contains an invertebrate fauna that has in it many Cretaceous elements; *Mactra alta, Cardium speciosum,* and several species of *Inoceramus,* being also found in the Fox Hill group. 2d. It contains, according to Professors Marsh and Cope, a vertebrate fauna which is decidedly Cretaceous in character. 3d. The somewhat numerous mammals recently obtained from the Laramie by Professor Marsh are reported by him to have decided Mesozoic characters. Among the reptilian remains found in the Laramie are many Dinosaurs, a group of which no representative has hitherto been seen in the Tertiary, and the great horned reptiles *Triceratops* and *Ceratops* are among the most remarkable of all extinct animals.[1]

The Laramie group is a formation that is essentially confined to the Rocky Mountain region; it forms a marginal belt on the east side of the mountains, extending from Central Mexico far into the British possessions. On the west side of the Rocky Mountains, it stretches over to the Wasatch, but has not been recognized at any point west of the summit of that range. Everywhere it contains coal, frequently in large quantity and of excellent quality. These coals are opened along the eastern side of the Rocky Mountains at Erie, Marshall's, Florence, Walsenburg, Trinidad, etc.; and from these sources the rapidly growing towns of the prairie region are receiving most of their fuel. On the west side of the Rocky Mountains, in Colorado, the Laramie coals are more important than elsewhere; the aggregate thickness in some places of several beds is fifty feet or more; the coal varies in composition from hard anthracite to open-burning bituminous, and much of it is of excellent purity, the amount of ash ranging from two to five per cent, the sulphur often less than half of one per cent.

[1] See meeting of October 28th, *ante.*

It is from this formation that coal is taken at various points along the Union Pacific Railroad at Coalville, Pleasant Valley, and Castle Valley in Utah.

The relations of the Laramie group to the coal-bearing rocks of the Puget Sound region are very intimate, and it is certain that, in part at least, these two series were synchronous; many of the fossil plants are common to both, and the relative geological position is essentially the same.

Most of the so-called Denver Tertiary beds really belong to the Laramie group, at least those beds which contain the remains of *Ceratops* and the stratified ash-beds of South Table Mountain. These latter represent the upper part of the formation, and fully one-half of the fossil plants contained in them are also found in the Lower Laramie at Golden, Florence, Trinidad, etc.

In Europe, the formations which indicate by their fossils the nearest approach to the Laramie are the paleocene plant-bearing beds of Sezzane, Gelinden, and Alum Bay. It is not known that any species found in these localities is represented in the Laramie flora; and in the absence of all connecting links, we should be unwarranted in calling the Laramie paleocene from its fossil plants, while its mollusks and vertebrates forbid this.

DR. J. J. FRIEDRICH presented the following communication:[1]

ON SOME NEW SPECIES OF PROTOZOOTITES, QUATERNARY AND TERTIARY, FROM CALIFORNIA, AND ON THE IMPORTANCE OF PROTOZOA AS ROCK-BUILDING AGENTS.

In looking over the Tertiary and Quaternary collections in the geological museum of Columbia College, I noticed a specimen of a grayish, fossiliferous marl of Quaternary age from the coast of Scandinavia, which appeared to be entirely identical with specimens collected by me on the Pacific coast. About seven miles south of Point Lobos, San Francisco, the coast hills approach the ocean abruptly, and the shore is so precipitous that no regular beach exists. This feature continues to the north for over a mile. Some portions of the beach at this locality may be accessible to exploration at very low tide, which, just prevailing at the time of my visit, exposed a very limited stretch of the beach bottom. My attention was immediately attracted by the semi-solid, plastic character of the fossiliferous bottom, the shells being chiefly Mytilus and Tellina. The specimen from Scandinavia

[1] The material referred to in this paper was presented at the last meeting before the summer adjournment; but as there was not time for its proper discussion then, the paper was deferred, and is here given in full.

also contains a specimen of *Mytilus edulis*. The magma could easily be removed, and after exposure to the air it became dry and firm. The northern outspur of this range happened to be a peculiar rock formation of considerable thickness. This dark-colored rock is strongly ferruginous; it is the youngest member of the Lake Merced region, which is considered to be of Tertiary origin. After heating a small piece in muriatic acid, a gritty pulp remained, which to the touch felt like infusorial earth. The microscopical examination gave a very interesting result. The first look at the slide showed a striking likeness with the view given by a drop of water taken from the sediment of an aquarium or a collection of marsh-water material. How was I prepared to recognize this fact immediately? I have been studying protozoan life for years, and in order to become especially acquainted with the rock-building material furnished by protozoa, I collected specimens from all different sources; and being familiar with the natural habitat of the different protozoan divisions,—some feeding and living in the water, top or bottom, others being firmly attached to plants, while others only breed and vegetate in the ooze and sediment,—I had no difficulty in providing myself with abundant and favorable material. I put the material in large, flat dishes and left it undisturbed for months. Let us take one of the dishes, in which life is absolutely extinct, and subject it to a careful scrutiny with the naked eye. We observe an amorphous, soft, pulverulent mass, of various shades of color, and, generally along the periphery of the dish and slightly floating, a considerable quantity of larger spherical masses, consisting of the excreta of vermes (Serpula, Naïs, Planaria, etc.), crustacea (Gammarus, Cypris, Cyclops, etc.), and rotatoria (Rotifer and Hydatina). But we have to resort to the microscope in order to differentiate this amorphous mass. As the ultimate result we obtain :—

1. A granular organic detritus, vegetable and excrementitious; these two can often not be distinguished in the absence of chlorophyll.

2. The mineral remains—siliceous or calcareous—shells, skeletons, cuirasses, envelopes, encasings, etc.

Some of these mineral remains preserve the typical character of the living protozoan, the skeleton of which forms its most important characteristic; the color, ornamentation, etc., being an essential guide to a diagnosis. Such are :—

(*a*) Thecoflagellata—Trachelomonas and Phacus; and Thecocilioflagellata—Peridium.

(*b*) Diatomeæ.

(*c*) Thalamophora or Foraminifera.

(*d*) Heliozoa.

(*e*) Radiolaria.

There is another group of mineral remains which offers much more difficulty to a direct diagnosis, but which numerically, in our latitude at least, is much more important than the preceding ones. In the living specimens, possessing a very attractive system of organs and charming principally by a display of their various functions, the skeletons form only a secondary part. But in the buried remains the skeletons, occurring in great abundance, come to the foreground. They are white, almost translucent; they have a well-defined, generally angular contour, and are only identified by the practised eye. These remains are derived from the following groups :—

(f) Ciliata.

(α) Heterotricha—Coleps, Freia, etc.

(β) Hypotricha—Euplotes, Aspidisca, Ervilia, Trochilia, Chlamydodon, Uronychia, etc.

(γ) Peritricha. The family of the Vorticellidæ is the most important; those with a vaginal mineral envelope—Vaginicolæ—are Cothurina, Vaginicola, Planicola, Opercula, Stylocola, etc.

(g) Acinetæ.

The only mineral remains yet to be mentioned are :

(h) Sponges—spiculæ and needles.

(i) Skeletons of rotatoria and crustacea.

This biological detritus, which in nature is formed on a very large scale, is the substratum, out of which the so-called infusorial or diatomaceous earths have been formed. I propose the term protozoötite as more appropriate for this group of rocks, composed of biological detritus, the largest percentage of which belongs to the Protista family,—Haeckel's group of Protista including the Protozoa, as formerly classified. It will readily be understood that the chance of observing this biological detritus unaltered, as originally dumped during its process of formation, is seldom offered, and that my surprise at what I saw under the microscope in examining the ferruginous protozoötite was indeed very great. The porosity and hygroscopic power of this rock explain the remarkable freshness of its state of preservation. It contains, in fact, miscellaneous biological detritus; but the organic ingredients—vegetable or excrementitious—are predominant. Chlorophyll is well preserved, especially in Euglena, also spores of diatoms. A small fragment heated in the closed tube yields water, gives a white sublimate and thick yellow drops; an empyreumatic odor is very perceptible; it blackens completely, but is not magnetic; the genesis of this ferruginous protozoötite is therefore fully explained.

Protozoötites are not uncommon in California, especially in the Coast Range. Not far from the locality where this ferru-

ginous rock occurs, in the hills immediately west of Lake Merced, they are found in a layer six feet thick. In looking over the geological collection in the Bureau of Mining in San Francisco, I saw a rock-specimen from Lake Merced labelled "pumice-stone." This specimen, in fact, gave the impetus for my trip to the Lake Merced region and the coast hills. Arrived at the spot, which is known as the pumice-stone mine, I discovered immediately the nature of this deposit; it was simply a bed of infusorial earth, conformable both above and below with sandstone layers; the dip is due west, sloping towards the Pacific.

This protozoötite, microscopically examined, presents the same aspect as the ferruginous species, minus the organic detritus; the view of the mineral remains is therefore unobstructed and very distinct. Diatoms are less frequent, but skeletons of ciliata are abundant.

A specimen from Sonoma Co., forming a layer ten feet in thickness, is very rich in diatoms, resembling the Virginia specimens closely: Melosira, Pleurosigma, and Navicula are the most common forms.

The Quaternary marl first mentioned contains also biological detritus, especially the shells of a small brown rhizopod, and likewise Navicula. In the closed tube it behaves somewhat differently from the ferruginous protozoötite, showing that it contains less organic detritus; only a trace of water is given; hydrogen sulphide is developed; it blackens, but not as much as the former, and contains some magnetic particles. This Quaternary protozoan marl is composed of the following ingredients:—

1. Disintegrated material of the protozoötites and sand-rock in the coast hills.
2. Magnetic sand, abundant along the beach.
3. Shells (entire and in fragments),—remains of living mollusks.
4. Shell fragments and detritus from Cretaceous rock-fragments and pebbles washed on to the beach in large quantities.
5. Biological detritus of the locality, such as rhizopods, etc.

I have yet to report on another category of altered, impregnated, or metamorphosed protozoötites,—the bituminous and asphaltic protozoötite. In the list of California minerals we find the mineral Jouite, under the heading of Lignite, as an obscure hydrocarbon; it is generally found in contact with lignite or asphaltum beds. Microscopical and chemical examination have determined it as an asphaltic protozoötite, in which the organic, especially the vegetable, detritus is remarkable. Algæ form the principal part,—the cellular structure often well retained. Of rhizopods, flagellata (Euglena) thecoflagellata (Phacus), etc.,

individuals with distinct outlines are inferior in number; the waxy portion contains not so much detritus: flagellata and ciliata—Vorticella, for instance,—which do not possess a mineral cuirass, are plainly distinguishable; I also observed the complete skeleton of a rotifer (Rotatoria). Heated in the closed tube, Jouite fuses, evolves thick yellowish fumes, a dark-brown liquid with strong bituminous odor and water; during calcination on a nickel plate it melts and burns with a good flame; a fine ash residue remains. Jouite contains, therefore, a very large percentage of a pure hydrocarbon. The last specimen, a bituminous protozoötite from the neighborhood of Santa Rosa—Putz's Gulch—bears in its physical appearance a strong resemblance to Jouite; it is in contact with lignite, lignitic shale, and sandstone. It contains,—besides a large percentage of organic matter,—flagellata, ciliata, diatoms (Melosira and Pleurosigma), rhizopods (Gromia), spores, encysted monocellular embryos, etc. Heated in the closed tube, it behaves like the ferruginous protozoötite, except that white fumes are evolved (not ignitable) emitting a strong bituminous odor like peat, showing that it is richer in bituminous matter. It is also strongly ferruginous; the iron may be derived from the lignitic shale, which is rich in pyrites; during calcination it glows and preserves its shape.

November 11, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Forty-two persons present.

DR. FRANZ BOAS, having removed from the city in consequence of his appointment as Docent in geographical science at the Clark University at Worcester, Mass., and having sent a request for transfer to the list of Corresponding Members in consequence of such removal, was so transferred by vote of the Academy.

PROF. CHARLES F. CHANDLER, as a member of the General Committee of the proposed World's Fair of 1892, sent a letter requesting that the Academy appoint a Committee to coöperate with him in regard to the scientific department of the Fair, should New York be chosen as the place.

It was so voted; and the Chair announced that he would name the Committee afterward.

The paper of the evening was then read, entitled

THE TEACHING OF NATURAL SCIENCE IN SCHOOLS.

BY H. HENSOLDT.

The author presented, with great beauty and clearness, the varied and important grounds upon which science has claimed, and in measure obtained, a larger share than formerly was accorded to it in the curricula of schools and colleges both in this country and abroad. He pleaded earnestly for yet further enlargement in this direction, and opposed strongly the occupation of time in our institutions by the pursuit of ancient classics and higher mathematics, regarding these as bygone forms of culture, which have served their purpose, and must be laid aside, or reduced, in the interest of branches more adapted to the needs and the spirit of the present time.

The paper called forth an active discussion, participated in by MR. SIEBERG, DR. BOLTON, DR. A. J. RICKOFF, MR. H. A. KELLY, DR. FRIEDRICH, the PRESIDENT, and others. The general trend of the discussion, while recognizing all that is claimed as to the importance of science in education, was not favorable to the abolition of either classics or higher mathematics as important elements of the course.

A VISITOR presented an earnest plea for the classical languages as the basis of all general culture, in distinction from a narrow specialism or a low "practical" materialism.

DR. BOLTON spoke of his experience during the years of his connection with Trinity College, as professor of chemistry, and of the marked superiority, even in scientific study, of those students who had enjoyed a classical training over those who had not.

DR. FRIEDRICH described the methods of science-teaching employed in the schools of Switzerland.

DR. RICKOFF stated that practical scientific instruction had been introduced with great success into the course pursued in

the Workingmen's School of this city, under the direction especially of MR. HENRY A. KELLY, who was present and could describe his methods more fully.

MR. KELLY, upon request, outlined the natural-history teaching in the Workingmen's School, and testified to the success and interest which attended it among the boys. The instruction is objective, and seeks to train the pupils to work and think for themselves, rather than by lectures or text-books. Excursions, etc., for observation and collection, are an important means of advancement.

THE PRESIDENT referred to the plans so enthusiastically advocated before the Academy a few years ago, by the late DR. EDOUARD SEGUIN, whereby the parks of the city were to be employed systematically as places for excursion and study for the pupils of the public schools, somewhat in the manner that MR. KELLY had alluded to. He also discussed the general question between scientific and classical training.

A large series of natural-history diagrams and charts had been hung in the hall, which were referred to by the President as illustrating the resources, in one form, now available to all schools at moderate cost.

November 18, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-five persons present.

THE PRESIDENT reported briefly upon the meetings which he had attended during the past week, in Philadelphia, of the Council of the American Geological Society and the Committee of the International Congress of Geologists. The latter body had been overtured in regard to postponing the meeting of the Congress from 1891, the proposed date, until 1892, in view of the Columbian Exposition in the latter year, and the advantage to foreign delegates of combining the two objects in a visit to this

country. No definite action had been taken; but the question was to be made the subject of correspondence, in order to obtain the sentiment of the foreign delegates generally.

The first paper announced for the evening was then presented, entitled

THE ROCK-SALT DEPOSITS OF THE SALINA GROUP IN WESTERN NEW YORK.

BY J. S. NEWBERRY.

(Abstract.)

Among the many important scientific and pecuniary results of the boring of wells for oil and gas in the country bordering the great lakes, is the discovery of thick and extended sheets of rock-salt where they were not before suspected to exist, and where they are likely to become sources of wealth.

The first of this series of wells was that bored for oil at Goderich, Canada, in 1866. Here, at the depth of about 1,000 feet, layers of rock-salt were penetrated, estimated to have an aggregate thickness of about 30 feet. The salt, separated from the shale with which it was mingled, was analyzed by Dr. T. Sterry Hunt and found to be of exceptional purity. Since that time a number of wells have been sunk at Goderich, Clinton, and Kincardine, and from the brines pumped from them in 1873 nearly two and a half million bushels of salt were produced, about one-half of which found its way to the American markets.

In 1876, the diamond drill having in the meantime come into use, Mr. A. Y. Attrill, of New York, purchased a tract of land at Goderich and drilled a well to the depth of 1,517 feet. At 1,028 feet the first bed of rock-salt was struck; this was 31 feet in thickness. At 1,085 feet the second bed, 25 feet in thickness, was reached; at 1,127 feet the third bed, 35 feet thick; at 1,223 feet the fourth bed, 16 feet; and the fifth and sixth beds, respectively 13 and 16 feet in thickness, were reached at the depths of 1,243 and 1,385 feet.

The cores of salt brought up by the diamond drill were examined by Dr. T. Sterry Hunt. Much of it was slightly stained with clay, from which it must be separated by solution before refined salt could be made. Ten feet of the second bed was, however, perfectly white and consisted of 99¾ per cent of sodium chloride.

The salt of Goderich occurs in the Onondaga salt group, and, as we shall see, is on the same geological level (Salina) with the beds of salt recently discovered in western New York.

In a large number of the deeper wells bored for oil in western Pennsylvania and Ohio, salt water was obtained. The production of salt from the brines of wells bored as salt-wells on the upper Alleghany, had become an important industry long before petroleum was sought for by boring; indeed, the quantity of petroleum in the wells at Tarentum first suggested to Mr. J. M. Townsend and Col. Drake the possibility of procuring petroleum in large quantities by sinking wells where the "surface indications" were strongest on Oil Creek. But none of these wells went deep enough to reach the salt-horizon, which we now know is the Salina group of the Upper Silurian system.

When, however, the oil-field of Pennsylvania was shown to extend into New York, many wells were bored in the upper valley of the Genesee. Little or no oil was obtained from these wells, however, for they were sunk below the oil-horizon; yet some of them reached down to the Salina group and very unexpectedly revealed the presence in it of heavy beds of rock-salt. In the upper part of the valley the salt-horizon was found to be 2,500 feet below the surface, but in the wells bored about Geneseo, the rocks all rising toward the north, the salt-beds were reached at from 800 to 1,500 feet. At one of these wells, the "Retsof," situated near Piffard, N. Y., a shaft was sunk to the salt, and it is now extensively mined. It proved to be of great purity, similar indeed to that of Goderich, and by simple grinding furnishes a table salt of a quality superior to that produced at Syracuse or Grand Rapids.

The extent of the rock-salt beds of the Salina group is not yet known. The point furthest north where they have been reached is at East Aurora, seventeen miles from Buffalo, where they lie 1,350 feet below the surface. West of this point, the rocks all dip westerly and the Salina group is deeply buried under the basin of Lake Erie, until we approach the Cincinnati arch, where it rises to the surface near Sandusky. It here contains no salt, but heavy beds of gypsum which are profitably worked.

Along the south shore of Lake Erie many wells have recently been bored for gas, and in one of these, at Cleveland, Ohio, a bed of rock-salt 164 feet in thickness was reached about 2,000 feet below the surface. Another well bored long ago for oil, near Ashtabula, Ohio, yielded a very strong and bitter brine. This has recently attracted attention and has been analyzed with unexpected results. The analysis was made by Stillwell & Gladding, chemists, No. 55 Fulton street, New York. The water filtered from the sediment contains in one U. S. wine gallon the following:—

Silica	2.91 grs.
Oxide of iron and alumina	8.73 "

Lime	1,380.00 grs.
Magnesia	378.40 "
Potash	446.00 "
Chlorine	1,267.00 "
Bromine	46.60 "
Sulphuric acid	1.00 "

If the brine from this well shall prove to be abundant in quantity, it may become valuable as a source of potash ; and this discovery indicates the possibility of finding in the great salt-field of the Salina group some localities where potash and the associated salts produced in such quantity at Stassfurt, may be found and may become an object of exploitation. Among the wells of western New York in which salt has been found are two at Mt. Morris, about 1,600 feet deep ; Greggsville, six miles north of Mt. Morris, four wells 990 to 1,030 feet deep : Le Roy, eight miles west of Greggsville, two wells 850 to 900 feet deep. Other wells have struck salt at East Avon, Batavia, Geneseo, York Station, Phillips, Piffard, Livonia, and East Aurora. A well at Piffard penetrated the following strata :—

Hamilton shales	407 ft.
Corniferous limestone	148 "
Water-lime with gypsum	118 "
Salina shale	105 "
Limestone and shale	70 "
Shale	102 "
Limestone	11 "
Shale and salt	30 "
Clear salt	22 "
Limestone and shale	28 "
Salt, second bed	4 "
Rock parting	2 "
Salt, third bed	58 "

The record of a well at Livonia, Livingston County, is as follows :—

Clay, gravel, and sand	56 ft.
Shale	461 "
Sandstone	10 "
Shale	302 "
Corniferous lime-rock	133 "
Hydraulic limestone	45 "
Limestone	313½ "
Shale and salt	11½ "
Pure salt, first bed	35 "
Shale	8 "
Pure salt, second bed	15 "

This well was perfectly dry and could only be bored by pouring in water from the top. This indicates that here, as at the Retsof mine, the salt-beds will be found to be dry and can be worked without the necessity of pumping, which will be a great saving of expense.

The limits of the salt-field of western New York are as yet very imperfectly defined, but it seems probable that the salt underlies an area many times larger than that where it is now known to exist; yet it is quite certain that it is not coterminous with the formation which contains it. About Syracuse the Salina group is well exposed and has been carefully studied by the New York geologists, but there are no beds of rock-salt in it.

So the Salina group extends from East Aurora, where it contains salt, northward under the city of Buffalo; but many wells have been sunk for gas in that vicinity, and they have passed through gypsum but no salt. It is at least certain that over a large area in western New York beds of rock-salt, from 15 to 30 feet in thickness and having remarkable purity, lie within 800 to 1,500 feet of the surface. Here they are within comparatively easy reach, and there is little doubt that many shafts will be sunk to them, and that the product of these mines will become an important factor in the salt-market of the country and a large contribution to the wealth of the State.

The salt-deposits nowhere extend so far north as the New York Central Railroad, and, as the dip of the rocks in all this region is southward from 30 to 36 feet per mile, in the southern counties the salt-deposits are so deeply buried that they are practically inaccessible; that is, the market can be more cheaply supplied from shafts sunk along an intermediate belt where the salt can be reached at a depth of 800 to 1,400 feet. Here, in the competition that is likely to be created by sinking numerous shafts, those in which the salt is reached at the least depth and is of the greatest purity, and where the amount of water to be pumped is least, will have an advantage that will enable them to monopolize the market. Wells sunk to the salt in the southern counties may yield a brine that will stand at nearly 100 of the salometer, that is, a saturated solution, but the operators in this region will be compelled to evaporate their brine and also to pump it from a much greater depth than is necessary at Syracuse, where the wells are only 300 to 400 feet in depth. Hence the salt industry will never be profitable in this region except in those localities, if such there be, where the brine contains unusual quantities of other ingredients than common salt and those that have higher pecuniary value.

Probably at many, or at least several, places within the great area where the Salina group contains salt, brines can be found

which, like that from the Ashtabula well, contain a large amount of potash and bromine, and these substances may be profitably extracted from them. With this fact in view, it will be desirable to have careful analyses made of all those brines which show to the taste that they contain an abnormal quantity of "bitterns," as only in such are bromine and potash likely to exist in paying quantities. Perhaps no such localities will be found within the limits of our State, but the possibility should be kept in mind.

The unequal distribution of the "bitterns" in the brines and salt of different localities is an interesting feature in these salt-deposits. In some places almost the only ingredient of the brine is chloride of sodium, and some of the rock-salt, as we have seen, is almost chemically pure; in other localities, perhaps not distant, the brine or the salt contains an abnormal quantity of the chlorides of calcium and magnesium and the sulphate of magnesia and soda. This problem has been carefully studied by Prof. Chas. A. Goessmann, and he has suggested what is doubtless its true solution, viz., that in the progressive evaporation of a basin filled with water having the normal composition of sea-water, the substances held in solution will be precipitated in the inverse order of their solubility;—thus sulphate of lime (gypsum), the least soluble ingredient, will be the first thrown down, the chloride of sodium next, and lastly, if at all, the deliquescent salts which form the bitterns. If, then, a salt lake like that in which the Salina group was deposited were, from the evaporation of its water, constantly contracting its area, in portions of its shallows a sheet of pure gypsum would be deposited when the evaporation had brought the solution to a point where gypsum could no longer be suspended. Over other portions of the basin pure salt would be precipitated when the solution could no longer hold chloride of sodium, and finally, as the water-surface contracted, in the narrower and deeper portions of the basin the bitter salts would accumulate in abnormal quantity.

This will account for the deposition of gypsum, of pure salt, and of unusually bitter salt, in different parts of the same basin. Facts illustrating this distribution of the solid contents of salt water are reported by Dr. Goessmann from the salt-basin of the Upper Ohio, and similar facts have been brought to light in boring the wells about Goderich. The salt there is of remarkable purity, but in a well bored twelve miles south from Goderich the salt was found to contain over 10 per cent of "bitterns."

For the better understanding of the nature and value of the rock-salt deposits of western New York, a few words may be said in regard to other known sources of salt in our country.

In 1887 the production of salt in the United States was 7,831,962 barrels of 280 pounds each. Of this, the value was estimated at $4,093,846. Michigan produced 3,944,309 barrels; New York, 2,353,560 barrels; Ohio and West Virginia, about 600,000; Kentucky, Tennessee, and Virginia, about 200,000; or about 7,000,000 barrels in all produced from the evaporation of brines. In addition, Louisiana produced 225,000 barrels from the quarries of rock-salt at New Iberia; Utah, 325,000 barrels, mostly from the waters of Salt Lake, but a small portion from the quarries of rock-salt in Jaub and Sevier Counties. California produced in former years over 200,000 barrels, chiefly from the evaporation of sea-water in San Francisco Bay, but in 1887 the production was only 28,000 barrels, in consequence of a combination of the operators to reduce the output and enhance the price.

In Kansas, a discovery of rock-salt has recently been made which promises to be an important addition to the resources of the State. The salt-beds lie near the base of the Trias, and occupy a large area in the southern portion of the State, extending into Texas. In seven localities cited by Mr. Robert Hay, in the Biennial Report of the Kansas State Board of Agriculture, the rock-salt lies at depths varying from 450 to 925 feet, and the thickness is from 75 to 250 feet. The production in 1888 was about 2,000 barrels.

In New York the production of salt is about equally divided between the Reservation at and about Syracuse and the Warsaw district in western New York, the latter having increased with great rapidity. The salt from the Onondaga Reservation is obtained from the evaporation of the brine of about 40 wells; these wells have an average depth of 330 feet, and the strength of the brine is about 70 per cent of the salometer.

In the Warsaw district there are about 50 wells in operation, from 800 to 2,500 feet in depth. According to the report of Dr. F. E. Engelhardt in 1887, the production of the different subdistricts was as follows:—

Warsaw	3,225,000	bushels.
Mt. Morris	510,000	"
Silver Springs	357,000	"
Le Roy	505,000	"
Piffard, Conesus Lake, and York	1,475,000	"
Total	6,072,000	"

The well at Piffard, belonging to the New York Rock Salt Co., is producing, as before stated, rock-salt, and is the pioneer enterprise of this kind in the State. The first bed of salt was

reached at the depth of 938 feet. This bed is 2 feet in thickness, and is separated from the second bed, 12 feet in thickness, by 4 feet of shale. The third salt-bed was 6 feet thick and 28 feet below the second; and the fourth bed, 9 feet below the third, was 58 feet in thickness.

Since the last report of Dr. Engelhardt, the production of this mine has greatly increased, but I have not received any detailed report of its business.

The paper was illustrated with maps, diagrams, and specimens.

Mr. A. W. Trotter made remarks upon the paper, and gave some further statistics of the Retsof (Piffard) mine.

The second paper announced was entitled

A NOTE ON THE COLORED CLAYS RECENTLY EXPOSED IN RAILROAD CUTTINGS NEAR MORRISANIA, N. Y.

BY F. J. H. MERRILL AND D. S. MARTIN.

Mr. Merrill described the mode of occurrence of these colored clays, which have attracted some attention of late. The region is the old valley of the Bronx, which, like all the valleys of this vicinity, had been much larger and deeper formerly. It was then partly filled with glacial drift, and was thereby dammed up near Williamsbridge. At the close of the ice-period, and during the following Champlain depression, it was occupied by still water, backed up into it by the relative increase of height in the sea-level, which amounted to some 80 feet. In this still-water fjord was deposited a large amount of stratified sand and gravel of various degrees of fineness,—some of it showing delta-structure,—which was carried into it by drainage-water from the north.

The valley owes its existence, in part at least, to the fact that erosion has operated much more powerfully on the crystalline limestone than on the adjacent gneissic rocks which form the bordering ridges. [This feature is marked in the Westchester region,—the valleys following the limestone belts wherever exposed.—Ed.]

In some places, undissolved masses of the limestone project into the stratified sand and gravel; and it is in connection with these that the "colored clays" occur. The layers are of very

limited extent, none exceeding 75 feet in length, and they represent the *aluminous residue* of the dissolved dolomite, mingled with more or less disintegrated limestone and ferruginous matter. They are reddish, white, and blackish, as are also the outcrops of decaying limestone;—the red color being due to ferric oxide, and the black probably to organic matter. The clays are conformable in stratification to the limestone, dipping steeply southeast.

Prof. Martin spoke of the attention that had been attracted by these parti-colored clays, which had been compared in aspect to the Tertiary beds at Gay Head, Martha's Vineyard. He had received a letter regarding them from Prof. T. Sterry Hunt, and had referred it to Mr. Merrill, whose familiarity with all the neighboring clay-deposits, and with Martha's Vineyard also, rendered him peculiarly qualified to investigate them, as well as the fact that he resided near the points of exposure.

A visit to the spot made by himself (the speaker), in which he had carefully traversed on foot the line of the railroad from Lower Morrisania to Fordham, proved both interesting and disappointing. Traces of the clay exposures were abundant, in material thrown out along the route; but the sections themselves were apparently concealed almost as soon as developed, by the rapid process of walling-up of the cuttings. At only one point had he gained a clear section that was at all characteristic. [This was shown on the board in a colored drawing.] The spot was a little below Tremont Station, on the east side of the road. The colors of the clays are very marked, and larger exposures must have been highly interesting. The varieties found by him [and exhibited in a suite of specimens] were,—white and grayish-white, ochre-yellow, bright brick-red, black (very black when moist), and a bluish-green, apparently consisting of decomposed chloritic material.

November 25, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Fifty-four persons present.

PROF. JOHN K. REES read the paper announced for the evening, upon

THE TOTAL SOLAR ECLIPSE OF DECEMBER 22D, 1889.

Total solar eclipses, taking into consideration the whole earth, are not very rare, about ten in eighteen years. However, the width of the path of totality being on the average less than one hundred miles, any one total solar eclipse can only be seen over a very small portion of the earth's surface—about 1–200. Hence it is calculated that a given place will be favored with a total solar eclipse only once in every 360 years.

If scientific observations are to be made on such eclipses, the astronomers must, to save time, follow the total eclipse-tracks about the earth. In the United States, during the present century, there have been visible the following total eclipses :—[1]

June 16th, 1806, visible in New York and New England ;—duration of totality 4½m.

November 30th, 1834, visible in Arkansas, Missouri, Alabama, and Georgia ;—duration of totality 2m.

July 18th, 1860, visible in Washington Territory and Labrador ;—duration of totality 3m.

August 7th, 1869, visible in Iowa, Illinois, Kentucky, and North Carolina ;—duration of totality 2¾m.

July 29th, 1878, visible in Wyoming, Colorado, and Texas ;—duration of totality 2½m.

January 11th, 1880, visible in California ;—duration of totality 32s.

January 1st, 1889, visible in California and Montana ;—duration of totality 2¼m.

The next total eclipse that will be seen in the United States occurs on May 27th, 1900, and will be visible from Louisiana to Virginia and have a duration of totality of 2m. Moreover, taking a wider survey, the tables of eclipses show us that after December, 1889, it will not be until April 16th, 1893, that another total eclipse will occur at any place where it can be observed. Then again observers will be compelled to go to South America and to Africa.

[1] Young's "General Astronomy," p. 245.

It is evident that every effort should be made to observe well the eclipse coming in December, 1889. During the year 1889 there occur five eclipses, three of the sun and two of the moon. Of the solar eclipses the first was total and visible in the western part of the United States on January 1st. Many important observations and photographs were obtained, and described at length in the daily papers and also before this Academy.[1] The second solar eclipse was annular, occurring June 27th; its path began in the South Atlantic Ocean, about a thousand miles south of the island of St. Helena, and the same distance west of the Cape of Good Hope. The path passed northeasterly to a point a hundred miles north of Madagascar, thence southeasterly, leaving the earth about one thousand miles west of Australia. Observations were made in Africa by astronomers from Capetown, Drs. Gill and Auwers, who obtained with the heliometer two hundred measures of cusps and of lines at right angles to line of cusps.[2]

The eclipse of December 22d, unfortunately, is visible in its totality phase only along the northeast coast of South America, in the Middle Atlantic Ocean, and in Africa. Four places have been selected by astronomers for their observations.

1st. The southern end of the island of Trinidad, at Point Icacos. Here totality begins at 7.06 A.M. and lasts 1m. 46s., the sun being at an altitude of only 12°.

The second station is at Cayenne, in French Guiana, where totality begins at 7.51 A.M. and lasts 2m. 3s., with the sun 24° high.

The path then crosses the Atlantic without passing over any islands, and at a point in mid-ocean about 300 miles south of Ascension Island the duration of totality is a maximum and is 4m. 15s.[3]

The third place available for an observing-station is where the path strikes the West African coast. Here the totality phase begins at 2.56 P.M. and lasts 3m. 12s., the sun being 46° high.[4]

A fourth point has been selected away from the coast up the Kwanza River.

Experience—and dearly bought—has taught the astronomers that it is best for one man to attempt to do but one thing during an eclipse. Unfortunately it happens that most eclipse observers are novices and are apt to forget this lesson of the experience of others,—they attempt too much and lose all.

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[1] TRANSACTIONS OF THE NEW YORK ACADEMY OF SCIENCES, Vol. VIII., Nos. 7-8, p. 156.

[2] The Observatory, August, 1889, p. 333.

[3] American Ephemeris and Nautical Almanac, 1889, p. 418.

[4] Monthly Notices Royal Astronomical Society, 1888, No. 7, p. 318.

The Royal Astronomical Society[1] has issued "stringent instructions" to two observers, each with an assistant, to make the observations necessary to answer the following questions:—(1) Whether the photographed corona changes perceptibly in two hours and a half. (2) Whether the supposed "extension" of the corona is a solar appendage or diffused light from the sky. (3) What is the photometric intensity of the corona at different points? The observers chosen are Rev. S. J. Perry, F.R.S., who, with his assistant, Mr. Rooney, will go to the Salut Islands, and Mr. Albert Taylor and assistant, who are to be stationed on the coast of Africa. Thus the observers will be many thousands of miles from each other. They will be equipped with precisely similar instruments. They will expose a few plates at times arranged upon, and on comparing the plates it will be seen whether the corona has changed photographically in two hours and a half. Question (2), as to whether the supposed "extension" of the corona is a solar appendage or diffused light from the sky, they will attempt to answer also by taking photographs. For this purpose the observers must have telescopes which will give enough light to enable the delicate "extensions" to be developed. Refractors with large apertures and required short focus are difficult to obtain for eclipse work; so that the English parties are supplied with reflectors made by Mr. Common. The mirrors are 20 inches aperture, 45 inches focal length. These mirrors photographed a great portion of the very faint nebula in the Pleiades in 30m., and the earth-lit portion of the moon in 2m. to 3m. If the photographs at the two stations agree in what they show of the extensions, then it would prove the extensions to be solar, and not atmospheric. If due to the atmosphere, the extensions would not be similar as seen in the two places.

The English parties will also take with them twin refracting telescopes (4 inch aperture, 5 feet focus), arranged for photographic work. Thus at each station will be a mirror and a lens, —an instrument for each observer and his assistant,—and each man takes three or four photographs. The comparisons of the two sets of plates ought to settle questions (1) and (2).

The third question will be answered by "placing beforehand on each plate a set of standard photographic squares, such as were described by Captain Abney to the Photographic Society, England, in 1885, and have since been used by W. H. Pickering at Grenada in 1887, and by him and others in California on January 1st of this year."

No spectroscopic work has been undertaken, for fear of endangering the success of the other observations.

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[1] The Observatory, November, 1889, p. 396.

Prof. Tacchini had thought of joining Father Perry, but was prevented, unfortunately for science, at the last moment.

It is reported that M. de la Baume, of Paris, an amateur who was disappointed in Russia in 1887, is going to Trinidad, and we have heard that Miss E. Brown and Miss Jeffries will be located somewhere on the same island.

A telegram received to-day from Prof. E. C. Pickering informs me that Harvard College will not send any party.

The Lick Observatory, through the generosity of Hon. Charles F. Crocker, will send a party to Cayenne. This party consists of Mr. S. W. Burnham, the distinguished double-star observer, and Mr. Schäeberle from Mount Hamilton. They will be joined by the well-known amateur, Mr. Rockwell, of Tarrytown. I have not seen any official statement of their apparatus or of the work they will attempt. There is no doubt that it will consist mainly in photographic work on the corona. Mr. Burnham will remain at Cayenne for two or three months, and examine the southern heavens for double stars.

The United States Government has sent a party to Africa under the charge of Prof. D. P. Todd. His chief assistant is Prof. F. H. Bigelow, of Washington. The Observatory of Columbia College is represented in this party by Mr. L. H. Jacoby, who is second astronomical assistant.

All the expeditions will pay great attention to the corona. Photographs will be made so as to show the details and the extension of the crown of glory surrounding the totally eclipsed sun.

Prof. Todd expects to take his party up the Kwanza River some one hundred miles from its mouth, and mount his instruments on the site of an old Portuguese fort. Here totality lasts about 3m., beginning about 3 P.M., with the sun about 45° high. He may send a party, under Mr. Jacoby, further into the interior, so as to avail himself of all chances. An attempt will be made by this American party to photograph the corona by polarized light. This has not been done before, and if successful will doubtless give valuable information about the details of the corona.

The region into which this expedition penetrates is considered very dangerous to health. Every precaution will be taken, and it is to be hoped that no loss of life will occur among these enthusiastic and devoted scientists.

On December 22d the sun will be very near the winter solstitial point; its motion in declination will be about 1″ of arc per hour; hence, during the short time that totality lasts, there will be only one motion to deal with—the diurnal motion of the earth. The latitude of the place of observation is about 9°

south of the equator. The horizon is therefore only 9° inclined to the axis of the earth. These facts enable Prof. Todd to arrange his instruments on a novel plan. The apparatus used for photographing the transit of Venus can also be used in photographing an eclipse. It has been so used; but it is troublesome to set up and to adjust properly. The United States expedition will discard all the apparatus except the 38-foot-focus lens and the camera-box. The lens will be screwed into the end of a 38-foot-long iron tube, at the other end of which is the photographic plate; on this plate will be formed an image (when the telescope is properly directed to the sun) four and a quarter inches in diameter. It is proposed by Prof. Todd to mount this long telescope as a tripod,—the telescope being one leg of the tripod. A second leg will have its foot resting in a close-fitting cylinder filled with dry sand; the cylinder will be supplied with a faucet for allowing the sand to escape. The whole apparatus is to be placed in such a position that the telescope will be pointed to the sun at the instant of totality; then, on allowing the sand to escape from under the third foot of the tripod, it is hoped that the telescope will follow the sun in its diurnal motion westward. Experiments made with the apparatus in Washington under Prof. F. H. Bigelow's charge, seemed to indicate that the apparatus could be readily handled and adjusted.

In the United States expedition,—for the first time, I think,—an attempt will be made to make all exposures automatically. Prof. Todd will place several photo-telescopes on a single polar axis, driven by a large clock.

The chances for cloudy weather on the African coast are great,—said to be one-half. Understanding this, Prof. Todd has taken with him a number of scientific men interested in branches other than astronomy, who will be able to bring back important results. Prof. Cleveland Abbe represents the United States Signal Service, and will make a special investigation of ocean air-currents. He carries with him on the ship some two thousand small balloons,—or rather the rubber skins and the apparatus for making hydrogen gas and filling the skins so as to make balloons about twelve inches in diameter. These are to be varnished and properly tagged, and then allowed to escape from the ship every two hours; they drag one hundred and fifty feet of thread. The air-current will carry them away, and after a while those that do not collapse may be caught in some ship's rigging, captured and sent to Washington, with tag and date as to when and where found. It is hoped that material will thus be obtained to give new information of value about ocean air-currents.

The Coast Survey Office sends Mr. Preston, an experienced

observer, who will swing a pendulum at various points for the purpose of determining the value of gravity acceleration. Mr. Preston accompanied the expedition to the Caroline Islands some years ago. Naturalists and botanists are also with the party : and Prof. Agassiz may join the expedition and dredge for deep-sea life near the coast. Should cloudy weather, therefore, make temporarily useless all the labor and pains spent on the eclipse apparatus, there will be still some important scientific results forthcoming.

The reading of the paper was followed by a number of lantern illustrations showing the appearances of the corona at various eclipses, including the photograph taken by Prof. H. S. Pritchett's party on January 1st, 1889.

ADDITIONAL NOTES ON THE ECLIPSE OF DECEMBER, 1889.

The total solar eclipse of December 22d, 1889, may be better understood in its special features by a consideration of the following figures:—

The moon in general moves in her orbit very nearly 2,100 miles per hour. This would be the rate of shadow-motion, were it not for the earth's rotation; but the rotation being to the east, the shadow-motion is therefore retarded. The earth's surface at the equator moves about 1,040 miles per hour. The motion of the shadow, the moon being in the zenith, would be, at the equator, the difference between 2,100 and 1,040, namely, 1,060 miles per hour. This is the slowest motion the shadow can have, about equal to the speed of a cannon-ball. The velocity is much greater than this at points north and south of the equator, where the earth's rotation is linearly less, and where the shadow falls very obliquely, as it does when an eclipse occurs near sunrise or sunset. The velocity, through these various causes, may be exceedingly swift, as great as 4,000 or 5,000 miles per hour.[1]

The eclipse of December 22d lasts, from the first instant that the shadow strikes the earth to the moment when it leaves the earth, 5h. 15.2m. The central eclipse lasts 3h. 23m.,—that is, it takes 3h. 23m. for the central shadow to move over the earth.[2] The length of path of totality is about 9,250 miles; hence, considering the motion as uniform, the central shadow moves over the face of the waters at about 2,700 miles per hour. The width of totality-path is variable, but on the average a lit-

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[1] Young's "General Astronomy," p. 237.

[2] American Ephemeris and Nautical Almanac, 1889, p. 418.

tle over 100 miles. Under the most favorable conditions possible, the cross-section of the central shadow in any total eclipse can have a maximum diameter of 167 miles, and totality may last 7m. 58s. In latitude 40°, under the same circumstances, totality can barely equal 6¼m.[1]

The central shadow, however, does not move uniformly over the face of the waters, and it may be interesting to consider how variable its motion is. The variability is shown, sufficiently for my purpose, by measurements from a map, as follows:—The central shadow on December 22d moves from where it first strikes the earth to the island of Trinidad, a distance of about 820 miles, in 2m. From that island to the equator it moves in 20m., a distance of about 1,495 miles; thence to the lowest point on the earth, a distance of 2,760 miles, in 1h. and 40m. Then it sweeps to the African coast in about 50m., a distance of 1,380 miles, and leaves the earth 31m. later, traversing in this last half-hour a distance of 2,800 miles.

"Summing up what we have learned about the corona during some 45m. of scrutiny in as many years, we may state, to begin with, that it is *not* a solar *atmosphere*. It does not gravitate upon the sun's surface and share his rotation, as our air gravitates upon and shares the rotation of the earth; and this for the simple reason that there is no visible growth or pressure downward (such as the spectroscope would infallibly give notice of) in its gaseous constituents; whereas under the sole influence of the sun's attractive power their density should be multiplied many million times in the descent through a mere fraction of their actual depth.

"The corona is properly described as a solar *appendage*, and may be conjecturally defined as matter in a perpetual state of efflux from, and influx to, our great luminary, under the stress of electrical repulsion in one direction and of gravity in the other. Its constitution is of a composite character. It is partly made up of self-luminous gases, chiefly hydrogen, and the unknown substance giving the green ray 1474; partly of white-hot solid or liquid particles, shining with continuous light, both reflected and original. There is a strong probability that it is affected by the periodic ebb and flow of solar activity, the rays emitted by the gases contained in it fading, and the continuous spectrum brightening, at times of minimum sun-spots, as if by a fall of temperature producing, on the one hand, a decline in luminosity of the incandescent materials existing near the sun, and, on the other, a condensation of vapors previously invisible into compact particles of sun-reflective capacity. The

[1] Young's "General Astronomy," p. 238.

coronal materials must be of inconceivable tenuity, since comets cut their way through them without experiencing sensible retardation. Not even Mr. Crookes' vacua can give an idea of the rarefaction which this fact implies. Yet the observed luminous effects may not in reality bear witness contradictory of it. One solitary molecule in each cubic inch of space might, in Prof. Young's opinion, produce them; while in the same volume of ordinary air at the sea-level, the molecules number, according to Stoney, 20,000 trillions."[1] It is to be hoped that Dr. Huggins' method of photographing the corona without waiting for a total eclipse may be carried to such perfection that in the future the astronomers will be able to study this "crown of glory" more comfortably and continuously.

[1] Clerke's "History of Astronomy during the Nineteenth Century," p. 236.

December 2, 1889.

REGULAR BUSINESS MEETING.

The meeting was held in the large lecture-hall of the Law School building.

The President, DR. NEWBERRY, in the chair.

About a hundred and twenty persons present.

The report of the COUNCIL was read, comprising the following recommendations :—

I. The election as Resident Member of

DR. MEADE BOLTON, of Brooklyn.

II. The payment of bills as follows :—

Publication of the ANNALS, Vol. IV., No. 12	$173.04
Separate edition of Constitution, By-laws, and Membership-lists, from Vol. VIII. of TRANSACTIONS	20.00
Expenses of wrapping and despatching publications	29.80
Other minor bills	26.10

The opening lecture of the Public Illustrated Course for the year 1889–90 was then delivered by MR. F. COPE WHITEHOUSE, upon the subject of

THE RAIYAN-MŒRIS, AND THE IRRIGATION OF ANCIENT AND MODERN EGYPT.

The lecturer discussed his own and other explorations in Egypt with reference to the location of the ancient Lake Mœris, and the various views that had been held regarding it. He identified it with a depressed basin lying to the west of the Nile, above the head of the Delta, the elevations of which he had carefully examined and tested, and which was unquestionably once connected with the river by the so-called Bahr Yusuf, or Canal of Joseph, asserted by Egyptian tradition to have been constructed by the eminent patriarch. It only needs that this ancient channel should be cleared, through a portion

of its length, from sand and rubbish that now obstruct it, to cause the Raiyan-Mœris basin to be filled at high Nile, and thus to constitute a great storage reservoir for the irrigation of the surrounding country during the dry season. This enterprise he had been urging upon the Egyptian government for some time, during his residence and exploration in that country; but the unsettled state of affairs had thus far prevented. He felt certain, however, that the question is merely one of time, and that this important improvement would ere long be undertaken and easily carried to a successful issue.

The lecture was illustrated with photographic projections of numerous maps, representing the history of Egyptian cartography and the various locations assigned by different authors and explorers to Lake Mœris, as also with views of the region more particularly described in connection with the project of MR. WHITEHOUSE.

THE PRESIDENT spoke in high terms of the interest and importance of the scheme proposed in the lecture, and of the great zeal and enthusiasm shown by MR. WHITEHOUSE in its advocacy. Such an enterprise would be of incalculable benefit to the land of Egypt, and would entitle its projector to a place among the benefactors of mankind.

A vote of thanks was proposed to MR. WHITEHOUSE for his scholarly and valuable lecture, and passed unanimously.

December 9, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Forty-three persons present.

The Librarian, DR. BRITTON, made a report of progress, and read a list of 185 societies and institutions now exchanging publications with the ACADEMY.

The subject for the evening was a conference upon Forestry,

and the first paper was read by Dr. H. Nicholas Jarchow, upon

THE PRACTICAL INTRODUCTION OF FOREST-CULTURE INTO AMERICA;—THE DIFFICULTIES, AND HOW TO OVERCOME THEM.

When I last had the honor, now a year ago, of addressing this learned audience in behalf of the forestry interests of our State, I showed that the Forestry Act, passed by our Legislature in the year 1885, if properly executed, was a great step toward the arrest of further devastations of the natural forests owned by the State; but that, in order to repair the damage done during a century to the beautiful mountain-forests in the Adirondacks, more effective measures should be taken, of which the first would be the establishment of a forest-school for training young men properly to care for the preservation and restoration of the woods. Our Forest Commissioners have since their installation moved on pretty slowly, and contented themselves with saving the woods in the Forest Preserve from the axe of the lumberman and from the torch of the careless or wilful incendiary.

Now, I do not know whether the gentlemen of that Commission have been influenced by the transactions which took place in this hall a year ago; but it is a fact that,—as the present President of that board lately told me,—there will soon be established a nursery for raising seedlings to restock the many denuded woodlands in the State Forest Preserve. This nursery, I am sure, will only be the precursor of the much-desired forest-school; and when we have obtained this, the time will arrive when we may boast of having discovered the way in which we may be able not only to restore and preserve our woodlands, but also to exploit them and to transmit them in good shape to future generations, who will need them just as much as we do. In other words, we shall have reached that period when systematic forest-culture can make its appearance in our State.

What is forest-culture? What is systematic forest-culture? These are questions which I often hear propounded. I shall answer by referring to a closely allied branch in the economy of a nation, viz., agriculture. While the latter endeavors, by correct management, to produce, without exhausting the soil, and at the smallest expense, crops of grain and fodder, the aim of scientific or systematic forest-culture is directed to producing a growth of trees for fuel, timber, and lumber, in such a way that, when a crop of trees is felled, certain measures are taken

to secure at once a proper after-growth under methods of preserving the most favorable conditions for the development of the young trees.

You will thus perceive that,—without taking other reasons, especially the economic importance of forests, into consideration, —forest-culture is just as essential to the welfare of a nation as agriculture. Why is it now that, while American agriculturists have taken every opportunity to advance the science of cultivating and cropping the fields, and have for this purpose always been in communication with the leading agriculturists and chemists of the Old World,—why is it that here the forestry interests, which are so intimately connected with the agricultural, could be neglected in such a degree that, unless the present devastation of our natural forests is at once arrested, and means devised to restore the denuded woodlands, the end of the second century of our republic will undoubtedly face a real wood-famine ?

The reason is simply this :—that the country at the time of its settlement was blessed by a benign Providence with too many and seemingly inexhaustible natural forests, so that in some places the superabundance of wood was often a hindrance to the efforts of the farmers to increase their arable lands. This condition, however, has changed greatly during the last fifty years, especially in our own State. Here Governor De Witt Clinton, in a message to the Legislature, complained of the denudation of the woodlands in the Adirondacks, and urged the fostering of forest-planting as an object of primary importance. But after the superabundance of woods and forests with us has gone long ago, and now that for a quarter of a century almost the entire press of the Union, public-spirited and disinterested men, and especially the American Forestry Congress, have made the most vigorous efforts to arouse public sentiment upon the subject and to bring about a change in our forest policy all over the country, why is it that we have made so little progress in this direction ?

The reasons are twofold : One is the diversity of the conditions in regard to the proprietary land system here and in Europe ; and the other is contained in the very nature of forestry.

In order to conduct the business of forestry,—for it is a real business, contemplating the continuous production of wood to furnish material for the supply of fuel, timber, and lumber of a nation,—there are required :—

1. Large continuous tracts of land stocked with forest-vegetation.

2. A considerable capital, represented by such tracts, and tied up for a long time before paying accumulated interest.

3. A careful management, yielding full results only after a term of years has expired, exceeding by far the lifetime allotted to men.

While in the countries of the Old World the holding of large estates by governments, communities, churches, corporations, and even by private persons, is not only permitted but, with regard to forest-culture, often fostered, as there are many areas which are unfit for agriculture and yet can be made profitable by growing forest-trees thereon, the ideas underlying our land-system go in the opposite direction. We are opposed, on principle, to the extensive holding of lands, not only by federal and State governments, but even by private persons, if they should select lands to provide for the benefit of the issue in their families beyond the second generation.

The urgent necessity of preserving forests for general economic reasons has, however, already made a mighty inroad into this public sentiment; for from all sides Congress is pressed to withdraw from the market the sale of the federal woodlands, amounting to about seventy millions of acres ; and several States, foremost among them our own Empire State, have set apart suitable lands and constituted forest preserves.

There are many other difficulties in the way of changing the unsettled condition of our forest policy. They all can be traced back to former superabundance of woods and the wastefulness caused thereby. This tendency has remained even after the conditions under which it originated have disappeared. It was primarily caused by the ignorance that prevailed as to the importance of forestry interests and the management of forests, and was nourished and fostered by the seeming inexhaustibility of our natural wood-supplies.

All these conditions, however, which have produced the present unsatisfactory state of affairs in this country, and which are very different from those that the European nations had to encounter, are disappearing every year more and more, and are bringing us not only nearer to the corresponding European prospect of wood-famine, but threaten to become even worse, unless the existing apathy in this vital matter shall pass away, and measures be taken to expiate the sins of former generations.

Other reasons why systematic forestry has not yet taken hold of this country, are found in the very nature of this branch of the economy of a nation. We have seen before, that forestry proper involves large continuous tracts of land. But how shall our average farmer, possessing from one hundred to two hundred acres, succeed in profiting by systematic forestry, even if he were inclined to help in the general effort for improve-

ment? The organization necessary for the proper administration of forests pays well with large properties, but not with small ones. Furthermore, the seeding and harvesting times are too far apart from each other: the forest-planter will never reap the full benefit of his labors. It is therefore very natural that the small farmer should have no more interest in timber lands as soon as the timber is gone. Why should he trouble himself with planting trees, the maturity of which he never will live to see, and on a property, moreover, which may soon pass into the hands of strangers?

The greatest difficulty, however, in the way of introducing systematic forestry in this country, is found in the fact that a comparatively large capital has to be furnished, which will be tied up for generations, and only at the end of a long period pay accumulated interest. This kind of business does not agree with the "average American." He prefers to keep his capital at his disposal, and when he uses it he expects high profits and quick returns.

And yet there are some features in the possession of well-managed forests which should make them highly desirable both for very rich men and for the government.

First. The investment is as safe as in the most solid savings-bank, and at a rate of interest which at least equals that at present paid by banks.

To prove this is not difficult; but it would lead me too far to-night if I should undertake to do it. I hope to have during the next year an opportunity to show the correctness of this assertion, and to demonstrate that the wealthier class of our citizens cannot make a better investment for themselves and their children, at the same time benefiting their country and their fellow-men, than by buying large tracts of woodlands and managing them systematically.

Second. The other point favoring the tenure of forests lies in this fact, that the labor bestowed upon them is much smaller than the amount of labor required in any other business, especially in agriculture. From the latest official reports about the revenues derived from the State forests in Germany, I see that the yearly expense for labor amounted to $2 per acre, and that the income produced by that labor was $5, leaving an average revenue of $3 per acre from soil which is mostly unfit for agricultural pursuits.

But just these two points,—viz., the small amount of labor required in the management of forests, and the great lapse of time between planting and harvesting,—render the possession of forests, although not desirable to private persons, yet very acceptable to governments and certain kinds of corporations,

such as churches, universities, railroads, etc. The American idea, it is true, does not favor the government's engaging in any business whatever. But in consideration of the two points just mentioned, we may fairly say that our governments should not only be permitted but even induced to acquire and manage forest-lands, because this is the only means to arrest the further destruction of our natural woodlands. When these come into the hands of the States, and are,—as I always presuppose,—properly managed, we must add to the material revenues of the forests their significance in the economy of nature;—their beneficial climatic influence in mitigating the extremes of temperature, their effect upon the distribution of rain, the protection of steep mountain declivities against land-slides, and of lands situated in the neighborhood of sand-wastes against being overblown by sand.

Of all States in the Union, there is none so favored in regard to forests as ours. Of the six million acres of woodlands situated in New York, nearly one million are the property of the State, while the rest belongs mostly to private parties who own tracts of from fifty to one hundred thousand acres. Through the operation of the Forestry Act, the Commissioners of the State forests are, as I remarked before, brought to the point of establishing nurseries for the reforesting of the denuded woodlands; and as the real preservation of forests cannot be effected unless they are properly managed, there is but one more step to take in order to reach the desired end,—that our State forests should be conducted on business principles. This would lead in time not only to a considerable addition to the income of the State treasury, but it would teach the owners of the adjoining large wooded tracts that systematic forestry is a paying business. They would give up their present policy of destroying their own property, and adopt a system similar to that introduced in the State forests, especially if the employed experts of the State were officially directed to assist with their advice the owners of private forests in their management.

In Europe, it is not the control of the government over private property, it is not the assumption of eminent domain, it is not police regulations, that have produced desirable effects upon private forests, but simply the example of a systematic and successful management of the State woodlands, and the opportunity offered by the government to the private forest-owner of availing himself of the advice and guidance of well-qualified officials.

Now, gentlemen, as soon as the Empire State has shown to its sister States not only the practicability but also the profit of a systematic management of forests, it is not extravagant to hope

that scientific forestry will gain a good foothold in other States also, and will exhibit the same great benefits which it has bestowed upon all countries into which it has been introduced.

The second paper was entitled

THE CONDITION AND NEEDS OF FORESTRY LEGISLATION IN THE STATE OF NEW YORK.

BY WARREN HIGLEY.

(Abstract.)

In this discussion I propose to consider the principal features of our forestry legislation as it now stands on the statute-books, to point out wherein they appear deficient, and to suggest such changes in the law as seem necessary to a successful forestry administration and to the best interests of the State.

The forestry interests of New York, take them all in all, are not surpassed by those of any other State. Our inland commerce and manufactures depend very largely upon the condition of the forest-covering of our great Adirondack water-shed, as also do our agricultural industries. And it is to this Adirondack region that our forestry legislation has been principally directed.

The "North Woods," "John Brown's Tract," or "The Adirondack Wilderness," originally belonged to the State and embraced an area of about 5,000,000 acres. It was covered with valuable forests. These lands were mostly sold by the State at a few cents per acre. A half-million acres of the best timbered lands were given as a *bonus* to the Saratoga & Sackett's Harbor Railroad Co. thirty years ago, and this company sold them to the Adirondack Railroad Co.,—its successor,—for five cents per acre, or $25,000!

The legislation of 1885 was largely hastened by the action taken by the Chamber of Commerce of the City of New York at its meeting held December 6th, 1883, led by Mr. Morris K. Jesup, who brought to the attention of the Chamber the threatened destruction of the Adirondack wilderness, and the consequent irreparable injury to the great water-ways leading to this city.

At this meeting a committee was appointed, with Mr. Jesup as chairman, with power to invite the co-operation of other associations and individuals throughout the State to urge the necessary legislation. The committee entered upon their work with great zeal. They called to their counsels Prof. Charles S.

Sargent, and at once took steps toward securing the desired legislation.

The New York *Tribune*, in its issue of December 14th, 1883, said in the course of an article on this subject: "The committee determined to circulate a memorial to the Legislature through the city and the State. It ought to have a hundred thousand signers before it leaves Manhattan Island. Our law-makers should be made to understand that the business men of the city are in earnest, and that they are not inclined to sit still and see the water-ways of our inland commerce destroyed.

"The disastrous climatic changes, the wasting freshets and parching droughts, which will be sure to follow the stripping of the tree-growth from these thousands of square miles, should be prevented at all hazards, and the matter has not been taken in hand a moment too soon."

The Act provides for the appointment of a Forest Commission by the Governor, by and with the advice and consent of the Senate, to consist of three persons, who shall serve for six years without compensation.

The Commission is empowered to employ a forest warden, forest inspectors, a clerk, and all such agents as they may deem necessary, and to fix their compensation. The expenses and salaries of such officers and employees are not to exceed, with the other expenses of the Commission, the sum therefor appropriated by the Legislature.

The "Forest Preserve" includes all the lands now owned or which may hereafter be acquired by the State of New York within the counties of Clinton (excepting the towns of Altona and Dannemora), Essex, Franklin, Fulton, Hamilton, Herkimer, Lewis, Saratoga, St. Lawrence, Warren, Washington, Greene, Ulster, Sullivan, Oneida, and Delaware,—the last two counties having been added since the original Act of 1885.

The law declares that:—

"The lands now or hereafter constituting the Forest Preserve shall be forever kept as wild forest-lands. They shall not be sold, nor shall they be leased or taken by any person or corporation, public or private."

This section was amended in 1887, to provide for the sale or exchange "of separate small parcels or tracts wholly detached from the main portion of the Forest Preserve."

Section 9 is so important for our purposes that I quote it in full. It is as follows:—

"The Forest Commission shall have the care, custody, control, and superintendence of the Forest Preserve. It shall be the duty of the Commission to maintain and protect the forests now on the Forest Preserve, and to promote, so far as

practicable, the further growth of forests thereon. It shall also have charge of the public interests of the State, with regard to forests and tree-planting, and especially with reference to forest fires, in every part of the State. It shall have, as to all lands now or hereafter included in the Forest Preserve, but subject to the provisions of this Act, all the powers now vested in the Commissioners of the Land Office and in the Comptroller as to such of the said lands as are now owned by the State. The Forest Commissioners may, from time to time, prescribe rules or regulations, and may, from time to time, alter or amend the same, affecting the whole or any part of the Forest Preserve, and for its use, care, and administration; but neither such rules or regulations, nor anything herein contained, shall prevent, or operate to prevent, the free use of any road, stream, or water, as the same may have been heretofore used, or as may be reasonably required in the prosecution of any lawful business."

This clothes the Commission with very ample authority and power over the important interests entrusted to it. As a general provision, it seems all that could be asked.

The provision empowering the officers under the Commission to arrest without warrant and prosecute for violations of the forestry laws, has proved of little avail, and must continue so to prove, from the fact that in the Adirondack region nine-tenths of the residents are either directly or indirectly connected with the lumbering industry, and have so large a sympathy with those who cut timber or otherwise trespass upon the lands of the State, that no local magistrate will bring the accused to an impartial trial, and hardly could if he were so disposed. A criminal conviction is quite impossible.

The Commission has found the same difficulty in its endeavors to recover damages for trespass under civil process, and it has asked the Legislature to make a law providing for the trial of such cases in any county within the Preserve which the Commissioners may designate. But so far such enactment has not been had, and the damages awarded by the courts for the cutting and removing of timber and bark from the State lands have been very meagre in comparison with what they should have been.

Ample provisions are made for the prevention of forest-fires. The supervisor of every town in the State, outside the counties named in the Forest Preserve, is charged with the duty of protecting the State lands against trespass, under the direction of the Commission. He is also ex-officio the fire-warden of his town.

Every railroad company whose road runs through waste or forest lands, or lands liable to be overrun with fires, in this

State, is required twice in each year to cut and burn off, or remove from its right of way, all grass, brush, or inflammable material, under proper care against the spread of the fire; and it is required that the locomotives on such roads shall be provided with sufficient arrangements for preventing the escape of fire from their furnace or ash-pan, and sparks of fire from their smoke-stacks.

In seasons of drought these railroad companies are charged with employing a sufficient additional number of trackmen for the prompt extinguishment of fires. A penalty of $100 is imposed for the violation of any of these provisions.

This Act further provides for the fine or imprisonment of any person who shall wilfully or negligently set fire, or assist in setting fire, to any waste or forest land belonging to another or to the State, whereby the forests are injured or endangered. He shall also be liable for all damages that may result from such fires.

Instruction in forestry in schools is provided for in the following terms :—

"The Forest Commission shall take such measures as the Department of Public Instruction, the Regents of the University, and the Forest Commission may approve, for awakening an interest in behalf of forestry in the public schools, academies, and colleges of the State, and imparting some degree of elementary instruction upon this subject therein."

And the law further provides for public instruction through the preparation and free distribution of tracts or circulars of information upon forestal subjects.

In these provisions the Legislature contemplated, no doubt, a most important work, requiring rare fitness in the Commission and much labor.

These educational provisions, so far as I have been able to learn, have been as a dead letter in the administration of the Forest Commission. Since the establishment of this Commission, public agitation of this question in New York seems to have subsided. The people have become apathetic,—resting in the sufficiency of the law to secure the desired ends so long labored for.

After four years' trial the people are awakening to the fact that the laws and the Commission have not proved effective in preventing, or even checking to any considerable degree, the destruction of the forests in the Adirondacks, or on other watersheds of the State, or in promoting forestry instruction in the institutions of learning, or in distributing forestry literature among the people, or in reforesting any part of the State lands.

The State now owns an aggregate of 855,986 acres of land in

sixteen counties. Of this, about 88,000 acres have been added since 1886 by forfeitures through tax sales,—the only provision thus far made for increasing the State's holdings. The lands thus acquired are generally of the most worthless character, denuded of timber, and largely rendered incapable of tree-growth for a century to come, through the frequent ravages of forest-fires.

The counties of Essex, Franklin, and Hamilton, constituting the most important part of the Adirondack water-shed, embrace within their borders 3,448,960 acres, of which the State owns 615,744 acres,—less than 18 per cent,—scattered in comparatively small bodies amidst the holdings of private or corporate owners.

This is a fair presentation of the most important forestry legislation in New York, with the exception of an act establishing Arbor Day, approved by the Governor April 30th, 1888.

It is perhaps the best that could have been secured at the time, in view of the powerful opposition of some of the lumbermen in the northern part of the State.

The administration of our forestry laws has not checked the progress of forest denudation in the State, and especially in the Adirondack region.

On the contrary, the lumbering interests there have continually increased and grown more active. Under the influence of a growing demand for forest products and of better facilities for transportation, this industry has been carried into the heart and centre of this great water-shed, where tower the loftiest peaks, and from whose heights the great rivers of the State have their beginning. Here Mt. Marcy rises more than 5,000 feet above the sea, and up near its top is a beautiful lake, embowered in overshadowing forests, in which the Hudson takes its beginning. A short distance to the westward, Mt. McIntyre, "The Thunderer," rises to nearly the same height, and also has a lake "above the clouds" that is another source of the Hudson. And there stand the neighboring mountains, all rising to great heights and together forming the crown of the principal water-shed of the State.

This region, while covered with the primeval forests, was of enchanting beauty, and most impressive in the grandeur of its scenery.

But to-day the lumbermen are there by the hundreds, busy in stripping the mountain-sides and valleys of their valuable covering, leaving in their wake the débris to feed the destructive fires when the dry season comes.

In this central region, and within a short radius of Mt. Marcy, the Hudson, Ausable, St. Regis, Raquette, and Mohawk have their source; and the lands around their head-waters, with the

exception of the Raquette, are owned by private citizens or corporations, over which the State has no control.

The forest product taken from the territory of the head-waters and tributaries of the Hudson last year aggregated in value not less than $4,000,000 according to the estimates made, and this is less than one-third of the output from the whole region. Preparations are making for a larger cutting in the coming year.

T. B. Harrison, Corresponding Secretary of the American Forestry Congress, a prominent writer on forestry, has recently been making a careful study, on the ground, of the condition of the Adirondack forests. In a letter written from the North Woods in August last, and published in *Forest and Stream*, he says :—

"The various railroads which penetrate the wilderness are being extended, and the destruction of the forests will, in consequence, proceed much more rapidly than heretofore. There has been a great deal of very indefinite writing and talk about the Adirondack forests, some of it misleading because not based on any considerable knowledge of the facts of the actual condition and course of things in the woods. From three-fourths to four-fifths of the original forest has already been cut off, and hundreds of square miles, hundreds of thousands of acres, have been utterly denuded and ruined by the burning and washing away of the soil, so that centuries must pass before those vast tracts of bare and sun-scorched rocks can again produce valuable trees. Any rational or fruitful way of thinking of the matter must embrace a recognition of these facts. Whatever we may desire, whatever 'might have been' if things had been entirely different, no amount of rhetoric or sentiment will avail to make the facts other than they are."

I have thus directed your attention to the principal provisions of our laws relating to forestry, and to the condition and alarming outlook of the Adirondack region.

I think I have conclusively shown that our present laws, as administered by the Forest Commission, have largely failed of their purpose, and the test of nearly four years' trial is quite long enough to form a reasonable conclusion.

I am of the opinion, too, that our forestry laws, with a few important changes and additions, are admirably adapted to our needs; and it is to these additions and changes that I now desire to call your particular attention.

1. The State should have the absolute right and control over not less than 2,000,000 acres, in addition to her present holdings, of the lands constituting the central portion of the Adirondack water-shed. This territory should be forever dedicated to the purposes of a Forest Preserve, which are not incon-

sistent with its uses as a park, a summer and health resort, and a game-preserve for the people. Nor is it inconsistent with a forestry administration similar to that which has been in successful operation in Europe for more than a century. There it has been demonstrated beyond all question or doubt that this territory can be reclothed with beautiful forests, the streams restored to their former fulness, and the matured product marketed so as to produce a handsome revenue to the State, over and above all the expenses necessary to its thorough maintenance and efficient administration, after the first five or ten years; and during this time large realizations can be had with advantage to it, rather than injury, as a Forest Preserve.

To this end, the State should take immediate and decisive measures for the purchase or absolute control of these lands; and until this can be done, the Legislature should enact a law providing that the lumbermen should cut no trees less than eight inches in diameter, and should so dispose of the tops and limbs as to leave no débris for the fires to feed upon.

The State has the sovereign right to make such provisions with regard to these and other lands as the public needs may require,—the right of *eminent domain*.

Eminent domain is the original ownership retained by the sovereign State, whereby land or other property may be taken for the public benefit. *Every species* of property which the public need may require is subject to be seized and appropriated under this right of eminent domain. Our public parks were so made through the exercise of this right, and our State and country are belted and interlaced with railroads that have acquired their right of way through country and towns and cities by the exercise of this same right.

The imperative duty of our Legislature to the people of this great State demands that this territory that feeds our rivers and canals should be at once taken from the control of the lumbermen.

2. The law should be so amended as to provide for the appointment of a *Forest Commissioner*, who shall receive a good salary for his services, in the place of the Forest Commission, consisting of three persons, who serve without compensation.

The Forest Commissioner should be a man well equipped with a knowledge of forestry, of good administrative ability, fearless in the discharge of duty, acquainted with public affairs, a good lawyer, an influential citizen, able to command the attention of public audiences, a successful champion of the cause of forestry before the people, and a wise, far-seeing, honest politician, able to convince legislators and command necessary legislation.

3. The law should be amended so as to provide for the trial

of causes, either criminal or civil, in any county of the Forest Preserve, at the option of the Forest Commissioner.

4. The Legislature should provide for the establishment and generous support of a scientific school of forestry in connection with some leading educational institution in the State, —as, *e.g.*, Cornell University,—with a thorough curriculum of studies, and a corps of instructors eminent for learning in their several departments.

There should be a further provision that the graduates of this school shall have the preference to be employed in the State forestry department, in such position as the Commissioner shall determine and the service may require.

The Forest Commissioner should be the head director of this school.

5. The Legislature should provide for the establishment of a Forest-Experiment Station in connection with every Agricultural College of the State, and these should be under the general direction of the Forest Commissioner.

With these amendments and additions to our forestry laws, and some minor amendments that will naturally follow, and with the *right man* appointed Forest Commissioner and clothed with all the dignity and authority which such a position demands, we may reasonably expect an administration of the forestry interests of New York that will prove the glory of the State and the just admiration of the nation.

DISCUSSION.

At the conclusion of JUDGE HIGLEY'S paper, the subject was thrown open for remarks; a number of members and visitors took part, among them Messrs. L. E. CHITTENDEN, E. B. SOUTHWICK, WM. H. HALE, D. S. MARTIN, JUDGE HIGLEY, PROF. F. W. HOOPER, and the PRESIDENT.

MR. CHITTENDEN remarked at length on the changes which had already taken place in the Adirondack regions, and likewise in that of the Green Mountains of Vermont, in consequence of the forest-destruction. In his view, one of the most ruinous and reprehensible practices is that of building dams on the Adirondack streams, to set back the water, and then use the "head" thus obtained to float logs down when released. This destructive practice should be among those prohibited by law. Its effect is to kill the trees in wide areas thus subjected to artificial but protracted overflow. In former years, the peculiar charm

of the Adirondack lakes was the richness and perfection of their forest margins,—the trees growing down close to the edge of the water, and enclosing the lakes like mirrors in a frame of verdure. Now this is utterly changed and destroyed, and the same lakes are surrounded with a belt of killed timber, the dead and spectral trunks forming a fringe of desolation; and all this ruin is wrought for the petty gain of the lumbermen in floating down their spruce and hemlock logs. He contrasted with this wretched method, which is being carried further and further up the streams every year, the management of Mr. Fuller, who had purchased a tract of land around Meacham Lake, and preserved it in its pristine loveliness, exhibiting great care and skill in the actual maintenance and profitable conduct of a woodland area.

He also described the contrast found by him recently in visiting his early home in Vermont. In former years the Winooski River was rarely fordable for teams, while now it is abundantly so. The process of denudation and desiccation is making fearful advance, and calls for the most earnest attention of thoughtful citizens.

After remarks by several gentlemen above-mentioned, strongly supporting the views of the previous speakers,—

Prof. F. W. Hooper stated that he represented the Brooklyn Institute, and had been at great pains to come over and attend this very important meeting. He trusted that the gentlemen who had read this evening would consent to appear before the Brooklyn Institute, and he could assure them of a very cordial and interested audience there. In conclusion, he moved the passage of a resolution by the Academy, approving the recommendations of Dr. Jarchow and Judge Higley, and the appointment of a committee, consisting of President Newberry and two other members, to further the interests of forestry legislation, in such ways as the Academy might deem advisable.

The resolution was passed; and the President named as the other members of the Committee, Mr. Chittenden and Prof. Martin.

December 16, 1889.

LECTURE EVENING.

Vice-President TROWBRIDGE in the chair.

Seventy-eight persons present.

The second lecture of the Public Illustrated Course was delivered, entitled

THE STRATEGIC FEATURES OF THE GULF OF MEXICO AND THE CARIBBEAN SEA.

BY CAPTAIN A. T. MAHAN, U. S. N.

The lecture was illustrated with a very large and carefully-prepared map of the entire region under consideration, and gave an exhaustive discussion of the routes, distances, etc., for naval and commercial operations in these waters, and the points of strength and weakness, of exposure and defence, etc., that are of importance to the United States, in connection with its foreign relations and its Gulf ports, in case of possible future complications, and with reference to the opening of one or more trans-isthmian canal-routes.

A unanimous vote of thanks was tendered to CAPT. MAHAN for his very important and instructive lecture.

December 23, 1889.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-eight persons present.

MR. J. BEAUMONT, of Colon, U. S. Colombia, was elected a Corresponding Member.

DR. H. CARRINGTON BOLTON read a paper entitled

CONTRIBUTIONS OF ALCHEMY TO NUMISMATICS.

(Abstract.)

After briefly stating the doctrine of the alchemists as to the transmutation of metals, the speaker remarked the universality

of the belief in the sixteenth and seventeenth centuries. The pseudo-transmutation of base metals into precious ones, whether accomplished by trickery or through ignorance of chemical phenomena now easily explained, was often commemorated by stamping medals or minting coins. The number of these hermetic rarities in numismatics is unknown; the speaker described, more or less fully, thirty-nine pieces mentioned in literature or preserved in cabinets. The chief sources of information are Samuel Reyher's "De nummis quibusdam ex chymico metallo factis" (Kiel, 1692, 4to); Köhler's "Historische Münzbelustigungen" (Nürnberg, 1729–50, 24 vols.); Madai's "Vollständiges Thaler-Cabinet" (Königsberg, 1765); and the alchemical works mentioned in the present essay.

The coins and metals described are the following:—

I. 1315.—Rose-nobles made from artificial gold prepared by Raymond Lully (Camden; Selden).

II. 1604.—Silver piece figured by Reyher (page 15), bearing emblematic figures and the signs ♂, ☿, ♀, in certain positions.

III. 1617.—A silver piece of the city of Erfurt, with the symbols ♀ and ☿ (Reyher).

IV. 1617.—Another of same date, with the image of a phœnix (Tenzel).

V. 1622.—A silver piece struck at Erfurt, with the same symbols as III. (Wedelius).

VI. *Fourth century.*—Coins mentioned by Tilemann, bearing the character of Mercury (Münz-Spiegel).

VII. 1630.—A silver thaler with bust of Anselm Casimir, coined at Mainz (Madai).

VIII. 1634.—A gold piece with portrait of Gustavus Adolphus and the symbol of Mercury (Monconys).

IX. 1632.—A double ducat of Gustavus Adolphus with an inscription referring to Ezekiel, chapter xxxvii.; struck November 6th (J. H. Scheler).

X. 1631.—A silver piece of Gustavus Adolphus, struck September 7th (Reyher).

XI. 1647.—A gold ducat of Christian IV. of Denmark, bearing a pair of spectacles, etc. (Köhler).

XII. 1647.—A medal struck by Ferdinand III. at Nuremberg, with alchemical signs for the seven metals (George Bauer).

XIII. 1648.—A medal of Ferdinand III., struck to commemorate a transmutation at Prague, January 15th (Zwelffer).

XIV. 1650.—A second medal by Ferdinand III. at Prague (Keyssler).

XV. 1658.—Mainzer ducats struck by Elector John Philipp, and described by Prof. Wedel (Monconys).

XVI. 1652.—A silver piece of low Dutch origin, preserved at Arnstadt, Thuringia (Reyher).

XVII. 1675.—Ducats struck by Leopold I. at Vienna, by agency of Wenzel Seyler (Burghard).

XVIII. 1677.—A large medallion of Leopold I., now (1889) preserved in Vienna (Herrgott).

XIX. 1677, November 6th.—Krohneman's medal of factitious gold (Fikenscher).

XX. 1678, January 8th.—A second medal by the impostor Krohneman (idem).

XXI. 1679, February 18th.—Krohneman medal (idem).

XXII. 1679, May 14th.—Krohneman medals, both in silver and in gold (idem).

XXIII. 1679.—A gulden struck by Krohneman on the thirty-sixth birthday of the Margrave Christian Ernest of Brandenburg (idem).

XXIV. 1679, November 16th.—A silver thaler struck by Krohneman on the birthday of the Crown Prince (idem).

XXV. 1681, February 18th.—A silver piece struck by Krohneman on the birthday of the Margravine.

XXVI. (no date).—A Krohneman medal by General Kaspar von Lilien (Fikenscher).

XXVII. 1686.—A medal attributed to Count Cajetano, with bust of Antonius Cajetanus.

XXVIII. 1687.—A ducat with bust of Frederick I., Duke of Gotha, with alchemical symbols (Tenzel).

XXIX. 1685.—A coin struck by Anthon Günther, Prince of Anhalt (Tenzel).

XXX. 1704.—Gold piece stamped by George Stolle at Leipzig (Kundmann).

XXXI. 1706.—A gold medal made by General Paykhull at Stockholm.

XXXII. 1710.—Gold medal made at Lyons by Delisle (Lenglet du Fresnoy).

XXXIII. 1717.—Silver thalers coined of artificial metal by Ernest Louis, Landgrave of Hesse-Darmstadt; also golden ducats (Güldenfalk).

XXXIV. 1732.—A silver triple thaler with portrait of Emperor Charles VI. and a burning phœnix.

XXXV. (no date).—A thaler or talisman with alchemical symbols (Madai).

XXXVI. (no date).—A medal of tin or pewter, with alchemical and symbolic figures and inscription, formerly in a private collection in New York. [Rubbing exhibited.]

XXXVII. (no date; between 1581 and 1619).—A thaler of Francis II., Duke of Saxony, with a long inscription and the

signs ☉, ☿, ☿. Preserved in the Royal Cabinet of Coins, Vienna. [A fac-simile exhibited.]

XXXVIII. 1675.—A silver medal with an inscription setting forth its conversion from lead by Dr. J. J. Becher, in July, 1675. Preserved in Vienna. [Fac-simile exhibited.]

XXXIX. 1716.—A gold medal commemorating the transformation of lead into gold, December 31st, 1716, at the hands of Charles Philipp, Count Palatine of the Rhine, at the Castle of Ambros, Tyrol. Preserved in Vienna. [Fac-simile exhibited.]

The last three fac-similes were obtained by Dr. Bolton in person, through the courtesy of the Director of the Royal Cabinet of Coins, Vienna, and prepared through the courtesy of the Keeper of Coins, British Museum.

In describing the foregoing medals and coins of hermetic association, Dr. Bolton narrated the circumstances connected with the alleged transmutations which they commemorated, giving anecdotes of the credulity of the royal or ducal patrons of the knavish alchemists who preyed upon them. He referred, in closing, to some modern treatises on alchemy, notably that of Cambriel (Paris, 1843) and that of Tiffereau (second edition, May, 1889), in which the authors, undaunted by the exposures of modern science, boldly offer to teach the transmutation of metals—for a consideration.

January 6, 1890.

REGULAR BUSINESS MEETING.

Vice-President HUBBARD in the chair.

Twenty-five persons present.

The Report of the COUNCIL was presented, recommending to the Academy:—

I. The election of the following-named gentlemen as Resident Members:

MR. FRANCIS T. GARRETTSON,
MR. EDWARD GUDEMANN,
HON. WARREN HIGLEY,
DR. MICHAEL PUPIN,
PROF. J. D. QUACKENBOS.

II. The payment of certain bills, viz.:—

G. Gregory, printing notices of meetings, etc.,	$26.50
Stationery (blank-books and envelopes),	7.89
Corresponding Secretary, postage, etc.,	6.09
Publication Committee, "	10.42

All the recommendations were approved, and voted as above specified.

The Committee appointed to prepare a memorial notice of the late PROF. COOK, of New Jersey, presented the following resolutions, which were unanimously adopted by the meeting, and ordered to be engrossed and transmitted :—

Whereas; PROF. GEORGE H. COOK—a Corresponding Member of this Academy, for many years State Geologist of New Jersey, Director of the New Jersey State Agricultural Experiment Station, Vice-President and Professor of Geology in Rutgers College, and the trusted counsellor in all matters in which science has served the State,—died at his home in the city of New Brunswick, Sept. 22d, 1889;—

And whereas; Professor COOK was one of the most beloved and most learned scientific men of his Commonwealth, an able and accomplished geologist, a skilful engineer, chemist, and agriculturist, and possessed of an unusually general and varied acquaintance with all branches of science;—

And whereas; Prof. COOK pre-eminently combined in his life the leader and worker in science, the genial and cordial gentleman, the patriotic citizen, and the Christian believer and philanthropist, whose hopes and labors reached forth beyond the narrow limits of all mere earthly environment;—therefore

Resolved; That in the death of such a man, this Academy recognizes a loss to humanity and appreciates the sad gap made in the ranks of American science;—

Resolved; That a copy of these Resolutions be entered upon

the minutes of the Academy, and another copy be engrossed and transmitted by the Secretary to his bereaved family;

N. L. BRITTON,
H. CARRINGTON BOLTON,
DANIEL S. MARTIN.

Committee.

NEW YORK, Jan. 6th, 1890.

The paper announced for the evening was to be read by PROF. W. GOOLD LEVISON upon

EXPERIMENTS IN PYROTECHNICAL PHOTOGRAPHY,

but, in consequence of the illness of the author, it was postponed to a later date. [The paper was presented on February 10th.]

In the absence of PROF. LEVISON, and in order to carry out the discussion of a kindred topic, DR. A. A. JULIEN had prepared, at very short notice, a paper entitled

SUGGESTIONS IN PHOTOMICROGRAPHY.

(Abstract.)

The processes of photomicrography are, in general, of the highest value, in association with drawing, in teaching any branch of natural history with the use of the microscope. Patient and long-continued observation with that instrument, in the ordinary way of study, is very difficult and trying for the young and inexperienced student. But in the production of a picture, both by freehand drawing with the pencil, and by photography, the artistic instinct is awakened, the observation becomes more keen, the judgment becomes trained, and a new interest is aroused in the object which is being studied.

The difficulties of photomicrography have been much exaggerated. With objectives of the lowest magnifying power, so easy is the process, and so captivating, that it might be substituted with advantage and profit, even in the education of children, in place of many of the "studies" for cramming the memory which have been long in vogue.

It is also not difficult to convey to the mind of even a child a good idea of the chemical reactions involved in photographic processes, so far as they have yet been understood. His practical

work may thus become intelligent, and he is fitted to cope understandingly with unforeseen obstacles. The mysterious action of light is, in itself, a subject of fascinating interest to the youngest student. It is important to make him appreciate the universal character of its chemical action,—that this is not confined to photographic gelatin plates, but has already become familiar to him in numberless instances; *e.g.*, in the tanning of his own skin where exposed to the summer's sun, and its whiteness where protected by clothing, in the variegated coloring and streaking of flower-petals where exposed to or shielded from the sunlight, in the bleaching of dyed curtains, muslins, etc., long exposed to light, and many similar facts.

The simplicity of the apparatus needed to obtain fair results was then explained and illustrated.

The more scientific and difficult applications of photomicrography were then discussed.

The great advantage of the yellow light of the common lamp-flame was explained, in connection with the use of color-sensitive plates and the proper color-screens. In the photography of bacteria and similar minute objects under high-power lenses, reference was made to the great value of the use of the simple little magnesia-beads, first suggested by Prof. Roux, in place of the ordinary lime-cylinders in the oxyhydrogen light. Their construction was explained, with the further recommendation to flatten slightly the end of the platinum wire, before its introduction into the magnesia-bead, in order to insure more perfect adhesion. A finer jet should be also substituted, in place of that used with a lime-cylinder, both for economy of gas, more intense illumination, and concentration of the flame on the bead, without danger of melting away the end of the platinum wire.

Attention was given to some of the peculiar difficulties yet attending the worker who has the most perfect results in view, viz.:—

1. The scarcity of perfect mounts of most microscopic objects, such as could be used to obtain unexceptionable photographs.

2. The complication of apparatus required for successful photography of living and moving organisms.

3. The difficulty in preparation of stable gelatin plates, sensitive to the red rays of the spectrum.

4. The interference of vibration and that of the Brownian motion in minute objects mounted in liquid preservatives.

5. The photography of opaque objects, especially those with brilliant or metallic lustre. A new method for this purpose was explained, with illustrations.

6. Decomposition of gelatin plates during washing in hot

weather; a plate was shown completely pitted all over with bacteria colonies.

A number of photomicrographic transparencies and prints were then exhibited, and an extension-scale of magnifying powers, determined on a large number of low and high power objectives.

January 13, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-five persons present.

A letter was read by the President from M. CHARLES BARROIS, of Lille, France, acknowledging with thanks his recent election as an Honorary Member of the Academy.

The paper announced for the evening was then read, upon

SOME ANCIENT SHORE-LINES AND THEIR HISTORY.

BY FREDERICK J. H. MERRILL.

(Abstract.)

In studying the surface geology of the vicinity of New York, the writer has observed a number of old terraces and shore-lines. One of the most prominent is the base-level plane which passes over the summits of the trap ridges of the Trias in New Jersey, and descends over the hill-tops in Westchester County to the north shore of Long Island Sound. This plane, with its northwest extension in New Jersey, has been referred to the Cretaceous age by Prof. Wm. M. Davis. As the region about New York City was depressed 400 feet or more in pre-glacial Quaternary time, while the "Yellow Drift" of New Jersey was being deposited, at least a portion of this plane was then submerged and must have been again subjected to the levelling action of the waves.

In the vicinity of Clarksburg, New Jersey, a shore-line has been observed on the red sand bed of the Cretaceous, and from its relation to the Tertiary formations it has been referred by the writer to the latter age. This Tertiary shore-line is about 240 feet above tide, and, though ill preserved, traces of it are noticeable on the eastern slopes of the Cretaceous hills of denudation throughout Monmouth County. With this fragmentary shore-line may be correlated a fragmentary base-level plane, sloping to

the southeast, on a portion of which the town of Freehold stands, about 180 feet above tide.

The estuary deposits of the Hudson River at New York indicate a post-glacial depression of more than 70 feet. In the basin between the Palisade ridge and the Orange Mountain, similar estuarine conditions prevailed, and the streams which flowed into that estuary formed delta-plains in water which stood about 80 feet higher than present tide-level.

The altitudes of the Hudson River estuary deposits have been determined at a few points as follows:—

Fort Lee, N. J.	70 feet
Mouth of Croton River	100 "
Peekskill	120 "
West Point	180 "
Fishkill	210 "
Vicinity of Albany	335 "

A preliminary study of these formations, in connection with those of similar origin in New Jersey, indicates that the lines of equal terrace altitude are nearly parallel to the Kittatinny-Shawangunk mountain range, and suggests that the elevation of these estuary deposits to their present height may be due to a change of altitude and attitude in the continental margin, caused by an uplift in the Appalachian system.

On the Long Island Sound shore of Westchester County, N.Y., the till which covers the metamorphic rocks has apparently been levelled off by wave-action at an altitude of 75 to 85 feet. Plains of this character occur at frequent intervals, being separated by river-valleys, and may have been formed during the post-glacial depression which occasioned the estuary deposits of the Hudson River valley. On one of the most extensive of them the village of New Rochelle has been built.

On Staten Island and western Long Island alluvial plains of stratified material rise gently from the ocean to the margin of the moraine, terminating at an altitude of about 80 feet, and, though no *continuous* shore-line has been found, these plains are referred provisionally to the same period as the estuary deposits a few miles north.

The 80-foot depression at the mouth of the Hudson River is believed by the writer to have been contemporary with one of equal amount at Trenton, evidenced there by distinct terraces which, however, have been considered by Mr. W. J. McGee to be of pre-glacial origin.

In studying the terraces of the Atlantic coast of New Jersey and of the shores of the Delaware estuary and bay, it was found that the principal Quaternary terraces were higher on the bay

shores than in the same latitude on the sea-coast. Lines drawn through the points of equal terrace-altitude bore about N. 55° E. This indicated that the terraces increased in height, not directly from south to north, but in a direction normal to the orographic axis to which the Cretaceous and Tertiary beds owe their present attitude and elevation above tide-level. The terrace heights were found to increase from about 25 feet in Cape May County, at Beesley's Point, to about 80 feet on a line drawn through Trenton and bearing N. 55° E. The slope thus indicated is about one foot to the mile.

Although this terrace-slope is greatest in a southeasterly direction, there is necessarily a gentle slope toward the south of a few inches to the mile. This was recognized by Prof. Geo. H. Cook.

The close parallelism of the strike of the Quaternary terrace plane to that of the Cretaceous bed throws some light on the orographic movements in this region during Mesozoic and Cenozoic time. The strike of the Cretaceous Lower Marl bed, as determined by Prof. Cook, N. 55° E., coincides very nearly with the generalized strike of the Triassic strata at their southern margin. The present attitude of the former is therefore dependent upon orographic movements parallel to that which primarily elevated the latter. One of these movements was pre-Tertiary and caused the unconformity between the Upper Cretaceous and the Eocene; another was the Quaternary differential elevation of the continental margin.

The present attitude of the New Jersey Trias is evidently due to an uplift along the gneissic axis which extends from Westchester County, N. Y., through New Jersey to Trenton and Philadelphia, and which will be referred to in the present paper as the Trenton-Manhattan axis. At their eastern and southeastern margin the beds are parallel in strike to the gneissic rocks. The dip of the former, except in the vicinity of the trap-sheets, is uniformly toward the northwest or toward the pre-Cambrian Highlands which border the Triassic basin in that direction. The Triassic strata, where they adjoin these metamorphic rocks, dip toward them. Their present attitude appears, therefore, to be independent of any orographic movement along the axes of the pre-Cambrian Highlands. There may have been differential elevation throughout the whole of the Triassic area at the time its beds were tilted, but, whatever the conditions, the uplift along the Trenton-Manhattan axis was the greatest.

The evidences of orographic movement along this axis have long been known to the advocates of the Triassic arch theory. These evidences do not require for their explanation, however, the hypothesis that the Triassic beds were continuous in extent from New Jersey into Connecticut. The first uplift along this line

was probably at the close of the Lower Silurian, and it was very considerable. This topographic change must, however, have been accentuated by the Triassic uplift. The stratigraphy of the region of New York and Westchester counties shows conclusively a general anticlinal structure with a southwesterly pitch.

If the Quaternary uplift in the region between the Hudson and Delaware Rivers had been in northern latitude alone, the strike of the Cretaceous must have been made to diverge from a direction parallel to the Trenton-Manhattan axis, and would have been more easterly than it is at present. If, however, the uplift had occurred parallel to that axis, any pre-existing parallelism between the strike of the Cretaceous and that of the Trias would have been retained, and the relation would be such as we find it.

As no satisfactory evidence has yet been found that an uplift occurred along the Trenton-Manhattan axis in post-glacial time, the phenomena of the elevation of the coastal plain in a direction normal to that axis may be explained by supposing that it was elevated by movement along the greater Appalachian axes to the northwest, which are essentially parallel in direction to the Trenton-Manhattan axis.

In connection with the matters under discussion, it may be remarked that, in the estimation of the writer, the line described by Mr. W. J. McGee[1] as a line of displacement, and which follows the margin of the metamorphic terrane from Trenton to the mouth of the Hudson, continuing northward along the valley of the latter, is not the limit between a region which has been elevated and one which has been depressed. It is not the limit between drowned rivers and those which are still or torrential. There are nearly as many drowned rivers on one side of the theoretic fault-line as on the other.

To the westward of this line, in the region assumed as one of no downward displacement, the Raritan is a tidal estuary to New Brunswick. In the Passaic, Hackensack, and their numerous tributaries, tide-water flows for a distance of several miles, and this estuarine region is occupied by a wide expanse of salt meadows. In the Hackensack meadows, moreover, the stumps of cedar trees are seen depressed below the level at which they could have grown. The old forest soil is overgrown with salt-marsh grasses and overflowed by the spring tides.

The channels of Murderer's Creek at Newburg, of the Wallkill at Rondout, and of Esopus Creek, are drowned at their mouths, and tide-water ebbs and flows in them. Again, on the east bank

[1] Seventh Annual Report, U. S. Geol. Survey.

of the Hudson, in the Highlands, there are the cascades of Broccy Falls east of Anthony's Nose, and of Indian Creek at Garrison's, equal in altitude to any on the west bank ; and as further evidence of the stability of this river valley, the Champlain terraces on the east bank are of the same height as those on the west.

The topographic trough which extends from the mouth of the Raritan to the Delaware, and which has been discussed by Mr. McGee as a result of displacement,[1] appears, from its relations to the Mesozoic strata, to be a trough of erosion. It is evidently the southward extension of the trough which has been excavated in the Triassic formation between the Palisade ridge and the first Newark mountain.

The hypothesis suggested in this paper as a tentative explanation of the Quaternary differential elevation of the continental margin in the vicinity of New York, seems to satisfy the conditions imposed by all the facts yet reported in the study of the Quaternary marine and estuarine deposits of the Atlantic coast. It remains for future investigation to prove it or disprove it. On *theoretic* grounds it cannot be considered impossible that an uplift should have occurred in Quaternary time along the mountain axes of the Appalachian system. The writer is informed by Prof. N. S. Shaler that in Massachusetts there is satisfactory evidence of a northward uplift. This may be attributed to elevation of the White Mountain region. Elevation in the Adirondack and Green Mountain areas would explain the presence of Quaternary marine deposits at an altitude of nearly 400 feet in the basin of Lake Champlain. An examination of the data accessible to the writer suggests to him that the highest terraces are on the flanks of mountains, and that the lower deposits are proportionately remote from them.

Of some significance in this speculation is the form and relative altitude of the ocean-bottom.

If there had been a Quaternary elevation of the continental margin toward the north, there should have been a consequent diminution of the depth of the sea, and, where the sea-bottom is unaffected by shore deposits or by erosive agencies, there should remain some evidence of this diminution. The parallelism of the 100-fathom curve to the general trend of the Appalachian system south of latitude 40° North, appears to be significant of a relation between the attitude of the coastal plain and some orographic movement in that system.

North of latitude 40° North, off the coast of Massachusetts, the position and direction of the 100-fathom curve suggest a more northerly uplift.

[1] Op. cit.

MR. MERRILL'S paper was discussed with much interest by the PRESIDENT, DR. BRITTON, and PROF. MARTIN.

The value of the suggestions presented, and the care shown in all MR. MERRILL'S work, were highly appreciated; although some question was expressed as to the possibility of a post-Triassic submergence of the whole coast region up to the base of the Highlands, such as would be implied by PROF. DAVIS'S view cited at the opening of the paper. Some deposits ought to remain over such an area of submergence, unless indeed its duration had been exceedingly brief.

PROF. MARTIN called attention to the presence of a small area of isolated clays lying upon the Trias within the general line of contact between that and the Cretaceous, a little northwest from Monmouth Junction (Pennsylvania R. R.). These were held to be Cretaceous by the late PROF. COOK, from whom he had received the account of them, only a few months ago; and if so, they would indicate an extension of that formation quite beyond our usual estimates.

DR. BRITTON held that the Cretaceous age of this deposit had not yet been fully established.

January 20, 1890.

LECTURE EVENING.

The President, DR. NEWBERRY, in the chair.

About one hundred and eighty persons present.

The third lecture in the Public Illustrated Course was delivered, as announced, upon

THE ICE AGE IN NORTH AMERICA, AND THE ANTIQUITY OF MAN.

BY PROF. G. FREDERICK WRIGHT, LL.D.,
OF OBERLIN COLLEGE, OHIO.

The lecture was largely illustrated with lantern views, comprising many taken by PROF. WRIGHT in Alaska, representing the glacier-scenery of that region, particularly a series of re-

markable photographs of the great Muir glacier, in various aspects. PROFESSOR WRIGHT also described and exhibited a small image of a human figure, either carved or moulded from hard clay, which is reported with much detail as having been brought up from a depth of many feet of soil, in an artesian well-boring in Ada County, Idaho. This object is about two inches long, perfect in condition, and spirited in execution; and if the positive assurances and affidavits of the finders are correct, it is probably the earliest, and certainly the most remarkable, prehistoric relic yet discovered in North America.

A vote of thanks was unanimously passed.

January 27, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Fifty five persons present.

An invitation was read from the Trustees of Columbia College, requesting the Academy to appoint delegates to attend the inauguration exercises of the new president, Hon. SETH LOW, to be held on February 3d.

The invitation was accepted, and it was voted that two delegates be appointed by the Chair.

Vice-President HUBBARD and Mr. L. E. CHITTENDEN were selected by the Chair as representatives.

Mr. RICHARD G. MOLDENKE, having removed to Michigan, was transferred to the list of Corresponding Members.

The first paper of the evening was then read, upon

THE NEWLY-DISCOVERED PHOSPHATE-BEDS OF FLORIDA.

BY DR. ALBERT R. LEDOUX.

The discovery of widely-distributed beds of phosphates in western Florida has of late produced a local excitement and activity similar to the "gold-fever" of a newly-opened mining region. Prospectors are everywhere, boring into the soil; capitalists from the North are seeking favorable openings from point

to point; the local press is wildly excited; and the native "cracker" occupants are suddenly aroused by a rise of value in their barren little holdings, that turns their heads with undreamed-of wealth. One poor man, at least, has become actually insane at realizing $300 for an option on his land, when probably he had never before seen such a thing as a twenty-dollar note.

As regards phosphate deposits in general, we may first glance at the two extremes of their occurrence. In the oldest rocks of the continent,—the Archæan of Canada,—we have the crystalline phosphate of lime (apatite) in large amount; while at the present time there are still forming extensive deposits of bird-manure (guano) on many islands like the Chinchas, etc. Between these extremes of age and of condition, there is every possible intermediate grade. On rocky islands like those off the arid coast of Peru, where rain is slight and rare, only fermentation occurs, and the phosphoric acid is largely soluble and combined mechanically with organic salts, as urates and oxalates. But when formed within the rain-belt, and constantly subject to its influence, the soluble compounds, including ammonia and phosphoric acid, are leached out. When this has occurred on limestone or coral islands, a third type of material is produced by the action of these leached-out compounds on the carbonate of lime, altering it to phosphate, as on Aruba and Sombrero. If there is much iron or alumina present, the less desirable phosphates of those bases may be similarly formed.

As to the rate at which bird-guano is accumulated,—which is the main source of the tropical phosphate-beds of recent geological time,—the following very definite evidence is of interest. I was personally acquainted with an intelligent captain who was sent to a coral island in the South Pacific for a cargo of guano. The island was uninhabited, and the birds were there in countless swarms. The same captain had been there twenty years before; and the place had been unvisited since that time. On this former trip, his men had built a hut of coral rock, after clearing off a space for it, and covered it with a piece of sail, as a shelter during their stay. On leaving, they took away the sail and left the "hypæthral" hut with its board flooring. On returning after twenty years, the fresh deposit had accumulated within the hut to a depth of twenty inches,—showing a rate of about one inch per annum,—while the underlying coral limestone was altered to phosphate for several feet, gradually passing into carbonate in going down.

At some points, especially in caverns (as *e.g.* in Cuba) bat-guano accumulates to a degree sufficient to become valuable in commerce. This material is easily recognized by containing

quantities of undigested horny wings, and other hard parts, of insects. Seal-guano is also known on some coasts. All these are geologically modern.

In the Mesozoic era, abroad, we find the remarkable "coprolite beds," formed in a similar manner by the great marine reptiles of the Jurassic time. These deposits have yielded thousands of tons per year, in Suffolk and Cambridgeshire, and are extensively and regularly worked like mines in many parts of the Continent, from Spain to Russia.

In our own country we have, besides the Laurentian apatite before referred to, a series of phosphatic marls extending along the seaboard region from New Jersey to Florida, and belonging to the early and middle Tertiary. The most important are the beds of the Ashley and Cooper river region in South Carolina, which are different from any others previously known. They were discovered in 1867, just after the war, and have been a priceless boon to the State and the country, aiding greatly in restoring the waste and desolation wrought by the war, both by fertilizing the sandy lands of the whole Southern coast region, and by furnishing a most important and profitable industry in mining, preparing, and shipping the material. Their use is extending over the entire United States, and the demand seems almost unlimited.

The "phosphate-rock" had been observed and to some extent recognized in its character, years before. But much of the land underneath which it lies is extremely barren, and perhaps for this reason the material was not considered of any especial value. I have myself analyzed soils that contain phosphoric acid up to six per cent, but so lacking in other elements of plant-food as to be wholly barren. Upon such lands it was that Ravenel discovered the method of producing an abundant yield by planting green crops and then "plowing under,"—thus furnishing the organic material necessary to act on the insoluble phosphates.

These beds are a wonderful repository of fossil remains. They consist largely of the so-called "nodules" of phosphate-rock, varying in size from a few millimetres to large masses; and intermingled with these, but not included in them, are quantities of bones and teeth of vertebrate animals,—sharks of great size, manatee, horse, elephant, etc.,—representing various periods from the Eocene to the Pliocene Tertiary. The nodules contain casts of fossil shells, but none of these vertebrate remains. The question of the manner in which these beds originated is one of great geological interest; but this is not the time for its discussion.

During the past year (1889) it is reported that the amount

taken out by the several companies operating in South Carolina was over 423,000 tons, and the dividends paid more than $400,000,—that is, nearly one dollar per ton. About one-half of this output was exported to points on the coast,—to Baltimore, Philadelphia, Richmond, and New York, in the order named,—about one-third sent abroad, and the rest manufactured into fertilizers at Charleston, or to a small extent sent into the interior for treatment.

The material is divided into "land-rock" and "river-rock,"—the former light-colored and dry, the latter dark and needing to be kiln-dried before shipment. The first is dug from the ground by pitting and trenching; the second is dredged from the rivers that cut through the strata of the region,—the nodules and fossils, in a rolled and waterworn condition, accumulating in the beds of the streams. So great is the demand, that during the year past the price of both kinds has steadily risen, averaging about $6.00 per ton at the beginning of 1889, and approaching $7.00 at its close.

Outside of this Ashley-Cooper region in South Carolina, the phosphate-beds have not been discovered in paying quantities, save at a few points in North Carolina. In some of the southeastern counties of that State, the yield may perhaps become valuable in years to come, when the South Carolina beds begin to be exhausted.

After these preliminary references to other phosphatic deposits, especially those near Charleston, I proceed to describe the newly-opened Florida beds, which form the proper subject of this paper. These are of two kinds, one closely resembling those of Carolina, both in character and occurrence, and the other entirely different.

In southern and western Florida we find a rather low region, nowhere exceeding 260 feet of elevation above tide. In crossing the State from Fernandina to Cedar Keys, following the railway survey in a direction N.E. to S.W., we pass over an alternation of valleys and ridges,—the latter sandy, and known as "pine lands"; the former swampy, and called "hammock lands." The elevations vary greatly along this line of section, from 20 feet to over 200; the average, in Marion County, being about 80 feet above mean low water.

Little attention has heretofore been paid to the geology of Florida, as it was not supposed that valuable deposits of any kind existed there. Up to 1881, the best summary of what was known or published upon the subject was that compiled by Prof. Eugene A. Smith, of Alabama.[1] After collecting and comparing the

[1] Amer. Journal of Science, Vol. XXI.

facts and views given by a number of geologists who have written more or less upon portions of the State, Prof. Smith goes on to say:—"From specimens collected by me at points widely distant from each other, from the observations of others as quoted above, and from the evidence derived from other sources, I am brought to the conclusion that almost the whole State of Florida, from the Perdido River on the west, eastward and southward, including the middle and western parts of the peninsula, certainly as far south as the latitude of Charlotte Harbor, has for its underlying formation the white or Orbitoides limestone of Vicksburg age, the exceptions as yet known being the Post-Pliocene or recent limestones forming the Keys and the immediate coast along the western, southern, and eastern shores, and isolated patches, if not a continuous belt, of Miocene limestone between the St. John's River and the elevated table-lands westward. In many places near the coast in Wakulla County a very finely pulverized marl is mingled with the sand, imparting to it a great degree of fertility; this is the 'Gulf Hammock' land of which much has been written. From inquiries and from the observations of Conrad and others, I learn that these hammocks exist all along the coast from Wakulla through Taylor, Lafayette, Levy, and Hillsboro Counties to Tampa Bay. This marl is also of Vicksburg age where I have examined it, and from descriptions which I have had from various sources it seems almost certain that the marls of the Gulf Hammocks in the other counties named are of the same geological age.

"About Ocala, southward and southwestward, is a belt of 'hammock' land, where an earthy, partly disintegrated limestone mingles with the surface soil. Reference to tables of elevations will show that this hammock land is 60 feet higher than the sandy plain of Ocala. My own observations in the interior confirm the statement of Conrad, with reference to the Gulf coast near Tampa, that the Tertiary limestone is certain to be the substratum of all the 'hammock' land. At Rock Spring, however, there is a bluff of limestone some 10 feet in height, and from this I was able to collect a number of fossils. They were submitted to Mr. Heilprin, who determined among them the following species: *Pecten madisonius, Venus alveata, Cardita granulata, Carditamera arata, Mytiloconcha incurva;* doubtful were also *Cardium sublineatum* and *Oliva litterata.* This would make the limestone of Miocene age, as Mr. Heilprin states his belief that no Vicksburg species are associated with the shells enumerated. I do not know that Miocene limestone has been observed elsewhere in the State, but it seems probable that it will, upon examination, be found either in isolated patches or forming a continuous belt between the Post-Pliocene

deposits towards the east, and the elevated country westward which has a substratum of the Vicksburg limestone."

After the above observations Prof. Smith summarizes as follows (which I condense):

"(1st) The Vicksburg limestone is the oldest rock in Florida, and therefore the State was still submerged until near the end of the Eocene period. (2d) After the deposition of the Vicksburg limestone (upper Eocene), Florida was elevated to its present level above the sea. (3d and 4th) After the Miocene submergence there was another elevation of Florida, followed (5th and 6th) by a submergence during the Champlain period, and then an emergence which brought about the present topography and elevations, substantially."

We may limit our discussion of the new phosphate-beds to the western counties, though rearrangement and restatement may at any time be rendered necessary by further discoveries. But for the present we will consider only the region of the Gulf counties south of Wakulla and north of Tampa. There appears to be a concentration also toward a central area, indicated by a circle of some fifteen miles radius around the town of Hernando, in Citrus County. The Withlacoochee River crosses this circle from S. E. to N. W., and within its limits are the towns of Dunellen on the north and Floral City on the south. Of course, wherever such a line is drawn, I am compelled to exclude some good localities that lie beyond it, and to incur the wrath of speculators and boomers elsewhere. But this statement merely indicates the centre of the region, while there are important deposits over an extensive area of the State beyond this limit.

The first kind of phosphate-beds above mentioned,—similar to those near Charleston, in appearance, composition, and occurrence,—have long been known, but have attracted little attention. Some years ago the occurrence of nodules and fossil bones in the outlets of creeks on the west coast, had been reported by officers of the U. S. Coast Survey. Fine specimens of them are in the Smithsonian Institution at Washington, and they were also exhibited at the Sub-Tropical Exposition at Jacksonville. More than ten years since, attempts were made to work these deposits at several points. The process is simple, and at the works of the De Soto Mining Company, at Peace River, is substantially as follows: A centrifugal dredge is anchored in the river, and the sand and pebbles taken from the bottom discharged into a revolving screen. The sand washes through, and the pebbles, which are entirely phosphate nodules, are delivered into barges and taken to the works to be dried and shipped. The company's storage capacity here is 1,500 tons. The material seems to be redeposited by the river almost

as fast as removed. This is probably due simply to a constant washing away of the fine sand, whereby the nodules are continually re-exposed. As compared with the Carolina phosphates, however, the small size of the nodules, and the consequently higher cost of working, seemed to preclude the idea of any very formidable rivalry on the part of these Florida deposits.

Until within a few months these were the only kind of phosphate-beds known in Florida, and were not considered of great importance; but in the fall of 1889 an entirely different material, but of great promise as a fertilizer, was discovered.

An orange-grower near Ocala, possessed of more curiosity than others around him, sent to a chemist for analysis a specimen of a white subsoil material occurring in his grove. It was familiar to every one in the region, but was supposed to be only limestone, for it had been found in all the wells in the neighborhood. The chemist reported that it was 80 per cent phosphate of lime. The secret got out, and then the excitement began. It may be said now, in all seriousness, that there is more danger that too much phosphate has been discovered than too little, and that a reaction will take place which may maintain values below the cost of Florida production for a while. Yet the world will take it all, and there is really to-day a scarcity in the market.

In the area described at the beginning of my remarks, covering Citrus, Marion, and Hernando counties, it seems that almost anywhere a pit or auger will reveal phosphate. In no opening that I visited in this section did I find it wholly absent. The very soil in some of the hammock lands is impregnated with it, as in South Carolina, while the ground around old wells and cisterns reveals its presence.

Outside of this region, as already said, both north, south, and west, there are undoubtedly large deposits whose extent and grade are as yet undetermined. They lie in lenticular beds upon the limestone,—or lime carbonate, as it might better be termed, as it is rarely hard enough to be called a rock,—and are covered by the sandy soil and clay subsoil, rarely cropping out at the surface. A valuable indication to me of their existence beneath the surface was an examination of the ant-hills and gopher-holes upon the tract. The earth thrown up by the former was interspersed with small whitish grains. These were found to be phosphate, and on digging or boring in the vicinity the deposit would be disclosed. A handful of sand from an ant-hill, submitted to analysis, showed the presence of about five per cent of phosphate. The material occurs at varying depths below the surface, from 2 feet to 10 or 12. In sinking a pit, it is sometimes difficult to tell where the clay ends and the phosphate begins; they shade into each other, at times gradually; at other

times the clay is entirely absent, the sand being the only thing between the surface and the valuable mineral. When wet they are dark or light yellow, but usually a dazzling white when dry. The thickness of the beds is very variable, and there is nothing to indicate it on the surface; it may be a few inches, or it may be 10, 12, or 16 feet of solid phosphate. A surface indication that is considered of value by some experts is the presence of masses of flint or silicious rock protruding from the soil, which seem to have segregated when the influences were at work which changed the carbonate of lime into phosphate, as has undoubtedly been the case. The area of some of the phosphate-beds is sometimes also defined by curious boulders and masses of a hard phosphate-rock, white or yellowish white, which has withstood weathering remarkably, and which is quite rich in phosphate.

As said, the phosphate proper varies in color from a dazzling white (when dried) to cream color. Professor W. P. Frost, of Savannah, to whose publication I am indebted for a description of the Dunellen field, which I did not visit, states in regard to the quantity: "I myself saw an auger bored 16 feet into this stuff without going through it. It remained of the same consistence throughout,—perfectly smooth and free from grit. It was a solid bank of phosphate 16 feet thick to my certain knowledge, how much thicker I do not know, but the natives, who are ignorant men, not knowing the value of the material, testified that they had seen wells dug 60 feet through this material to reach water-bearing strata." Professor Frost, in speaking of the area at Dunellen, estimates that over 3,000 (out of 13,000) acres are underlaid with the mineral, which occurs in ridges and pockets, running, by his analyses, from 50 to 65 per cent, and averaging between 55 and 60 per cent. Much of this new phosphate has reached the more northern mills, and is being experimented with,—several tons having been shipped to Atlanta and elsewhere.

It is the policy of those who are securing land,—and everybody in Florida seems to be of this class,—not to prospect too much or commence shipments until they have gotten all that could be obtained. Dr. C. U. Shepherd, of Charleston, the leading expert on phosphates in this country, has established a laboratory at Ocala, and with guides, tents, and horses is swinging round my imaginary circle, with headquarters near Floral City when I was there.

In what was said above, I have depended largely on reliable information, especially as to the more southern and northern sections of the phosphate area. My own observation was made in the area lying between the Withlacoochee River and two large lakes upon which are situated the towns of Thompkinsville and

Floral City. At the orange-grove of Dr. Hawkins, a mile southeast of Rutland Post-Office, on the river, the surface boulders showed the existence of phosphate, and it was apparent in the cistern which was being enlarged. On the adjoining plantation, in the midst of an orange-grove, several pits have been sunk, revealing the presence of phosphate in numerous nodules or masses in the sand, but not in place; these masses nevertheless being so numerous as to make up, I should say, fully one-third of the material excavated below a depth of three or four feet. The masses were of a yellow color and quite hard. These deposits were in high hammock lands near the river, but, owing to the difficulty which will be experienced on all low grounds, from water, many of this class will be comparatively difficult to work. But on the pine ridges which constitute the greater area in Citrus County, this difficulty will not be encountered, especially because it seems necessary to go through the compact phosphate material to strike water, and above this point, I believe, only surface water will have to be contended with.

Among these pine ridges in the vicinity of Floral City are many localities which have been carefully examined by others, and from which I procured specimens containing from 60 to 85 per cent of bone phosphate, the latter being a pure white article from the bottom of a well, which it was stated—and I have no reason to doubt the statement—was at that time 13 feet deep in solid phosphate.

Near Floral City were two properties (among many) controlled by Mr. Collin M. Hawkins, of Raleigh, N. C. In company with Dr. H. B. Battle, the North Carolina State Chemist, I examined these with considerable care, and the results will serve as a type of other lands in the vicinity. The tracts were rolling and consisted together of about 100 acres of sandy pine land, having some 15 or 20 acres in productive orange-groves. They had been developed by pits sunk at irregular distances in a zigzag manner across the field, being distant respectively from each other 138 yards, 226 yards, 93 yards, 84 yards, 60 yards, and 126 yards. They had all gone down until the phosphate was exposed, or until the owner of the land became discouraged at his supposed inability to find it. I may say here that with the eye alone the most experienced chemist,—unless his experience has been obtained in Florida, and that within 60 days,—is utterly at a loss, and his judgment no better than that of the average "cracker." I could not tell by the eye the difference between the carbonate of lime and the white phosphate, nor between the calcareous clay and the cream-colored phosphate, and was much surprised at finding large percentages of phosphate in samples from pits

which I had set down in my memoranda as not affording any promise. A sample from pit No. 2, marked by Dr. Battle as a poor specimen (in which I concurred), showed by analysis over 61 per cent of bone phosphate. The samples from the seven pits above indicated yielded respectively about 61, 58, 62, 69 (another "poor specimen"), 50, 32, and 41 per cent.

There had been other pits on this property, just over the line, opened by previous prospectors before the property came under the control of Mr. Hawkins, which had been carefully filled up before they left. These were not reopened during my stay, but specimens picked up on the surface showed 64.85 per cent of bone phosphate, 67.59 per cent, and 64.59 per cent. In one pit, situated upon a rise of ground, and which did not strike the phosphate until some 12 feet below the surface, an auger was run down to a depth of between two and three feet, and the boring yielded 50 per cent of bone phosphate ; as the auger had no handle, we could not go deeper.

The examination of these properties showed, first, the probable presence of phosphate underlying nearly the whole area, and, second, a considerable variation in the percentage at different depths. The deeper one goes into the material, the freer it is from clay and sand, and the purer. Unlike the samples from the hammock land that I have alluded to, these pits were quite uniform and solid ; but even in some of the hammock properties I am told that, in prospecting, the detached masses, if thrown on one side in digging and the sand on the other, will nearly equal the latter in bulk.

An analysis of the Peace River phosphate obtained by river-dredging, in samples submitted to me, and which are shown here, gave in the coarser particles 58.42 per cent of bone phosphate, and in the finer 60.38 per cent. In the samples from the Hawkins property spoken of, the percentage of oxide of iron and alumina varied from 5 per cent as a minimum up to 10 per cent as a maximum. In a sample from the hammock land, the maximum (15½ per cent) of oxide of iron and alumina was found. The presence of iron and alumina, so dreaded by many of our American fertilizer manufacturers, was detected very early in the examination of these Florida beds, and yet in practical working it was found that in spite of these elements the other difficulties usual in such cases were not encountered, and the rock dried out fairly well and did not "revert" after treatment.

Professor Frost, above quoted, called attention to this fact and says: "I can only account for these injurious constituents not acting in their usual way by supposing that the presence of lime counteracts their presence." I venture with some hesitation, in the absence of any thorough investigation, to say that from pre-

liminary tests I think another explanation possible. Besides the phosphate of lime, there is in all the samples a certain amount of carbonate rock,—in the rich specimens very little more than in the South Carolina,—and also a good deal of sand or matter insoluble in dilute hydrochloric acid. An examination of this latter shows the presence of considerable clay. As all of the phosphate is readily soluble in dilute acid, while the clay and silica are not, I am led to believe that perhaps the phosphoric acid is practically all combined with lime, and not with iron and alumina, and that this fact may have been overlooked by chemists who have simply determined the total amount of phosphoric acid, silica, alumina, and iron, regardless of their combination.

The nodules in the hammock district, which I analyzed, may compensate for their not being a continuous body by being of very high grade. The specimens I gathered showed respectively 74.32 per cent and 71.69 per cent of bone phosphate.

In closing, I desire to call attention to the fact that in the present stage of developments there is yet great uncertainty; that I have personally examined but one part of the field, and that somewhat superficially, but believe that the facts here stated, which have been obtained with considerable pains from reliable sources, will prove sufficiently correct to give a fair view of the situation; and that the phosphate trade may regard it as settled that there is an enormous quantity of high-grade material accessible, with comparative ease, in Florida, and that the centre of production must undoubtedly leave Charleston in the near future. While there is much wild speculation and reckless investment, there is also a magnificent opportunity for intelligent expenditure of money for well-chosen property, and great fortunes are to be made in the State, which but yesterday attracted little attention except for its climate and its fruit. For investors to go down at this late day is, perhaps, useless; but with the co-operation of those who have been in Florida from the beginning of the excitement, and have intelligently tested and secured the best lands, there is a splendid field for Northern capital.

The President remarked upon the great interest and importance of the statements presented by Dr. Ledoux, and referred to the fact that some years ago, when travelling in western Florida, his own attention had been called to the existence of phosphatic deposits in that region, of the kind first described in this paper,—similar to those of Carolina. He had seen specimens of the nodules and fossils, in the hands of private

parties near Tampa, but had not been able to ascertain their precise locality or mode of occurrence. Subsequently he had commissioned one or two assistants to make particular search for them, recognizing their probable value; but the endeavor had been unsuccessful. The other class of phosphate-beds, unconsolidated and widely extended, and just beneath the surface, is entirely new and possesses equal if not greater interest.

Mr. M. F. Knudson, President of the Peace River Phosphate Co., at Dr. Ledoux's suggestion, gave some further account of the occurrence of these deposits, and the manner in which their development and working are conducted.

The second topic of the evening was that of

REMARKABLE COLORED MARBLES FROM NEW LOCALITIES.

Mr. Bashford Deane exhibited a very beautiful series of polished slabs of light-colored marbles from Numidia, placed at his disposal for the evening by the owner, Mr. Fritsche. The peculiar interest attaching to these marbles is that they may in part solve a problem that has much perplexed antiquarians,—as to the source of some of the marbles employed in the decoration of ancient Rome, as, *e.g.*, in the baths of Diocletian. A great variety of such materials was used in the luxurious buildings of the later Roman period, but their localities have been utterly lost and unknown. Recently, in the region of ancient Numidia, explorations carried further inland than before, have come upon extensive marble quarries, filled with chips and débris, among which are old Roman tools. There is no possible doubt that we have here discovered the source of at least some of the favorite materials of the imperial city; especially as the specimens now obtained correspond to some of the Roman marbles.

Mr. Fritsche, by invitation, made a few remarks, describing the mode of occurrence and exploitation of the marbles exhibited.

The President spoke further on the subject especially of the great antiquarian interest of this discovery. He alluded to the fact that many years ago, while abroad, he had procured a very complete series of the ornamental stones of the city of

Rome, as obtained from the baths and palaces of the Cæsars; but that most unfortunately that collection has long lain under the sea, off the shore of Fire Island. It was on board the *Elizabeth*, the vessel that was wrecked there in 1850, on which occasion the ill-fated Countess d'Ossoli (Margaret Fuller) lost her life. On the same ship was brought over the statue of John C. Calhoun, executed by Hiram Powers. This was afterwards dredged up and recovered.

He then exhibited some other new marbles of striking character, from Manchester, Vermont. The leading type is a breccia of white fragments in a bright red matrix. This beautiful variety had been accidentally encountered by a farmer in excavating for the foundations of a barn, near the village named, and had attracted the notice of Mr. Schwartz, who was present this evening and would perhaps give some further particulars. The high color and striking contrast of this marble would render it very effective for certain kinds of large work, such as columns of doorways, etc. It was overlain by a bed of handsome blue-gray clouded marble, similar to that of some other quarries in the same neighborhood. Geologically, these are Lower Silurian,—parts of the Eolian limestone of Hitchcock,—which includes a large part of the marble belt of western New England, from Vermont down through the Berkshire Hills of Massachusetts and on by Connecticut to Westchester County and New York Island. Some portions of this belt are thoroughly metamorphosed into white crystalline marbles, as at Rutland, etc., and others, as in this case, much less altered. Mount Eolus itself, from which the series was named, is close to the village of Manchester.

He also spoke of the existence of extensive deposits of very beautiful black and variegated marbles in southern Nevada, and exhibited specimens of some of them. The locality of these fine materials had been hitherto practically inaccessible, though they had been known for some years; but now a railroad is under construction that will run quite near the deposits, and they will then doubtless appear very soon in the market, as an important addition to our American ornamental stones.

Mr. Schwartz gave some further particulars regarding the discovery and present working of the Manchester marble.

Prof. D. S. Martin called the attention of the Academy to the meeting of the New York State Forestry Association, announced to be held in the same building on February 1st. He extended an invitation to all persons interested in the preservation of the Adirondack forests and the maintenance of the water-supply of the Hudson River and the Erie Canal, to attend this gathering and aid the Forestry Association by their presence and their support.

Mr. G. F. Kunz exhibited a new specimen of meteoric iron, weighing 10½ pounds, called the Fairweather meteorite, as it was found, and is supposed to have fallen, near Fairweather Station, close to the dividing line between Burke and McDowell counties, North Carolina. It was found during the summer of 1889 by negro laborers at work on the railroad, and consisted of two pieces, weighing together 28½ pounds,—this one and another of 18 pounds.

He also showed photographs of two remarkable stone images or idols, supposed to be of Toltec origin, which had recently been brought to this city from San Juan Teotihuacan ("City of the Gods"), about 26 miles from the city of Mexico, on the Vera Cruz Railroad.

The three pieces forming the two images or altars weigh 3,500 pounds. They are covered with rude carving, and the mouths of both serpent-heads are large hollows, which would almost admit a human body, and it is believed that they were used for sacrificial purposes. The larger one is six feet high, the tail projecting upward from the body as a straight shaft or column, the entire head of which is covered with cement or plaster, which, in turn, has been coated with a red paint, except where removed by abrasion. These are evidently similar to the objects described by Charnay, the French explorer, on his famous expedition to this same region. These singular figures are now in the possession of Mr. William Niven, at 739 Broadway, New York City, and can there be seen.

February 3, 1890.

REGULAR BUSINESS MEETING.

Vice-President HUBBARD in the chair.

Five members present,—the inaugural exercises of HON. SETH LOW as President of Columbia College causing the absence of many of the officers and members of the Academy.

As the number in attendance was not sufficient to form a quorum for the transaction of business, it was voted to adjourn the business meeting for one week.

February 10, 1890.

ADJOURNED BUSINESS MEETING.

President NEWBERRY in the chair at first, and later Mr. L. E. CHITTENDEN.

Thirty-seven persons present.

The Report of the Council was presented, recommending action on the following points :—

I. The election as Resident Member of

MR. JOHN EYERMAN ;

and as Corresponding Member of

PROF. J. FRANCIS WILLIAMS, of Clark University, Worcester, Mass.

II. The transfer from Resident to Corresponding Member of

MR. F. COPE WHITEHOUSE.

III. The payment of bills as follows :—

Printing Annals, Vol. IV., No. 12	$125 94
Incidental expenses, Librarian	9 50
" " President	12 47
" " Publication Committee	10 42
Electrotypes of figures for TRANSACTIONS	15 50
Stationery purchased	8 00

IV. The list of nominations for officers to be voted upon at the

Annual Meeting, as prepared by the Council in accordance with the By-laws, was read by the Secretary.

The paper of the evening (postponed from January 6th) was then read by DR. WALLACE GOOLD LEVISON, on

THE PHOTOGRAPHY OF SELF-LUMINOUS SUBJECTS,[1] INCLUDING PYROTECHNICAL PHOTOGRAPHY.[2]

In that branch of photography which deals with self-luminous subjects, the specialties of solar and celestial photography have been chiefly developed, although others of later origin and perhaps of wider interest are included. Pyrotechnical photography, in so far as it embraces effects in fire, is one of these next likely to acquire prominence.

My acquaintance with the latter feature of it dates from the evening of Pain's day at Manhattan Beach, September 13th, 1884, when I exposed a plate in a small hand-camera upon an exhibition-piece near which I was standing on the lawn. The resulting negative suggested that, with experience, very attractive pictures of such subjects might be obtained. The present communication is a record of the results of a series of experiments which originated in this incident, with additional illustrations from other sources; but it also extends to the photography of self-luminous subjects other than fire-works. In this paper, the word "subject" is employed as a technical term pertaining to the fine arts and not as an equivalent for the word "object."

On September 17th, 1887, I again attempted to photograph one of Messrs. Pain & Son's designs in fire-works, which was occasionally shown at Manhattan Beach during that year, entitled "The Battle of the Monitor and the Merrimac." This picture includes one or two set pieces and affords an interesting study. The plate was exposed nearly all the time that the lances of the set pieces continued to burn, yet although they are quite actinic, they have not seriously halated it. The torrent of Roman-candle balls which, in the view, the Merrimac is pouring upon the Monitor, resembles a stream of water from a fire-engine hose; but in the original production these balls were projected separately, and successively traced their trajectories

[1] A paper read before the Brooklyn Academy of Photography, November 26th, 1889.

[2] Paper read before the N. Y. Acad. of Sci., Feb. 10th, 1890, and the Photographic Department of the Brooklyn Institute, Feb. 11th, 1890.

upon the plate. As the lens was open throughout the engagement, all the projectiles are accumulated in the picture and the terrors of the combat thereby greatly enhanced.

Such pictures as this are taken by the extremely simple method that is resorted to for photographing a flash of lightning at night. The camera is simply aimed where the discharge is to appear, and left open until it has occurred. When sufficiently sensitive plates are made, the astronomer by this method may register every meteor in a meteoric shower.

All fire-works, however, cannot be so easily photographed. If the camera be left open before a piece discharging a shower of fine sparks, each is separately photographed, but the numerous superposed images obliterate each other. This was illustrated by a view of a large wheel taken at Manhattan Beach on August 22d, 1889; while a second view taken on September 17th, 1887, by an exposure continued only during one revolution of a similar wheel, afforded the outer fringe in exquisite detail.

Since the summer of 1888, Mr. George S. Wheeler participated with me in several experiments; and as a result of but three visits with him to Messrs. Pain & Son's exhibitions, a number of charming views were obtained which, together with those mentioned, afford a fair abstract of an evening with the fire-works at Manhattan Beach. The series includes an exhibition piece taken August 21st, 1889, views of the large fountain and mines and the eruption of Vesuvius and the burning of Pompeii, taken August 22d, 1889, and the final flight or bouquet of rockets taken in August, 1888.

M. Albert Londe, of Paris, has made a number of large negatives of display fire-works, at various times. He has very kindly made and sent me a number of lantern slides from these negatives. They include views of bombs and gerbs, parachute gerbs, a revolving wheel, a bouquet of flowers, and a display from the second story of the Eiffel Tower, taken on July 14th, 1888. Mr. F. L. Lathrop, of Brooklyn, N. Y., has also made a few indifferent negatives of fire-works which were part of the Inaugural Centennial display on Fort Greene, Brooklyn, N. Y., about May 1st, 1889. The views presented comprise perhaps most of the more important at present in existence.[1]

From such subjects, we passed, at the suggestion of Mr. Wheeler, to photographing small pieces, chiefly Catharine and triangle wheels, hoping to accumulate on one plate the trajectories of all the sparks emitted by such a wheel, and thereby to produce a picture resembling that of a large piece. The

[1] I have since seen an example given by M. Abel Buguet;—Journal des Sociétés Photographiques, January, 1890.

pictures at first obtained only approximately afforded the expected result. The flame at the mouths of the cases produced a marked effect, but the trajectories of the sparks were less distinctly traced, owing either to their smallness, rapid flight, or low incandescence. Four-ounce triangles, rosette wheels, China flyers, and ten-inch vertical wheels all gave outer fringes in which the detail of the sparks was easily obliterated by long exposures, owing to the number and superposition of their images.

Seeking to obtain small wheels affording large and brilliant sparks, like those emitted by exhibition pieces, I found that the sparks from these were due to steel filings, which are not put in commercial wheels, as they are liable to be destroyed by rust before such pieces are used. From ten-inch vertical wheels containing steel filings, zinc filings, and powdered magnesium, made especially for me by the Unexcelled Fireworks Company, very attractive pictures were finally obtained. The so-called pot usually attached to small wheels, and consisting of a case of Bengal fire, was found to overpower the discharge from the driving-cases both by halation and illumination of its own smoke, unless it was arranged to light at the last moment and was photographed by a separate short exposure. From these experiments, it was concluded that the ideal small wheel for photographing should emit sparks about one-tenth of the size of Roman-candle balls, and might have one or two pots arranged to light without an explosion and burn only during one revolution of the wheel.

The "ghost," or reflection from the lenses, which is of less moment in ordinary photography, becomes so conspicuous in pyrotechnical photography as to be a matter of considerable solicitude. Views of wheels were presented in which an additional image resembling the circular ornament in the centre of the wheel appeared near the edge of the plate. That its circular form is not dependent on that of the primary image, was shown by pictures in which candle and lamp flames photographed by short exposures were accompanied by very distinct circular impressions obtained by longer exposures. In making some of these views, screens were used close to the plate-holder, to cover portions of the plate. The effects and the avoidance of these reflections in pictures by artificial lights, were discussed at length and illustrated by portraits taken by lamplight.

The next following views, showing brilliant haloes of several forms, obtained from the sun with various lenses, illustrated that the so-called halo which surrounds the disc of the sun when it is located in or near the centre of the plate, moves from the centre of the plate in one direction in proportion as the sun

moves away from the centre in the opposite direction. It was assumed that a bright star would afford a similar halo with sufficient exposure. This led to the suggestion that photo-telescopic lenses should be rigorously investigated in this respect, and that it should be demonstrated that such objects as the celebrated nebula in the Pleiades (which is revealed only by the photographic plate) are neither wholly nor in part an aggregate of such reflections from the group of stars within the field of view.

Photographs of Geissler tubes taken by exposures not exceeding five seconds in duration, and showing the stratified discharge in nitrogen, hydrogen, and carbonic anhydride, were next presented. The stratification was best obtained by a number of separate flashes made at about half-second intervals by breaking the primary current by hand. These were followed by other photographs of a Crookes' tube, showing the mean free path of radiant matter, in which the different phenomena resulting from reversed polarity and shifting the connections, were distinctly portrayed. The photographing of the high tension discharge in these various vacuum-tubes appeared to afford the following conclusions :

1. The bands of the stratified discharge seem to recur more nearly at the same points of origin when the primary current is broken at moderate intervals.

2. Either variety of discharge affords an impression with a Cramer (s 40) plate in five seconds or less ; hence but a short exposure would probably be required to photograph not only the form but also the detail of polar auroras. The reduction by the lens, and consequent concentration of the light, would probably lessen even this short exposure.

3. If comets are foci of radiant matter,[1] they may be photographed by short exposures.

Divers series of lantern views and negatives next followed, showing the effects obtained in several similar cameras simultaneously exposed, on the same self-luminous subject, but charged with various plain and ortho-chromatic plates. Carbutts' eclipse and eclipse ortho-chromatic plates made of the same emulsion ; imported and American eoside ; and plain Cramer (s 40) plates were employed. The spectra of barium and strontium, fire-works, and Geissler tubes afforded subjects. Cramer plates unstained developed the strongest impression of the latter subjects. In case of the spectra, the lines of the barium spectrum between *e* and *a* affected the stained and not

[1] Papers of the American Astronomical Society, No. 2 ; Brooklyn, N. Y., March, 1887, page 54.

the plain plate; but with the same exposure of several minutes, only the blue line of the strontium spectrum distinctly affected either plate, and that appeared to affect both about equally. Pure hydrogen gas, giving no spectrum of its own, was the flame employed.

The subject of reversal of the image was next discussed, and illustrated by several examples occurring in the case of fire-works, Geissler tubes, and direct views of the setting sun. From these it was concluded that important revelations might result from photographing objects illuminated successively by monochromatic lights of various wave-lengths; as an antagonistic or complementary action between the more and the less refrangible rays, most pronounced between the blue and red, seems to be concerned in reversals.

The utility of the photography of self-luminous subjects was next considered; and in illustration of its application for preserving historical mementoes, there were presented,—first, a view of the burning Brooklyn Tabernacle at night, and next a view, by M. Albert Londe, of the illumination of the Trocadéro in Paris at the opening of the Exposition.

But its utility was considered as more apparent in the production of combination exposures. These were exemplified by an interior daylight view of the electric exhibition in Philadelphia, decorated with electric lamps, taken on September 27th, 1884, and a daylight view of a zinc-furnace in operation, showing the flames of the burning zinc escaping from the mouths of the retorts. Another variety of combination exposures was typified by a portrait of a smoker lighting his pipe near a lighted lamp,—the lamp and match flames being taken by direct exposure, the portrait by flash-light.

Finally, a picture of a watch-spring burning in oxygen, obtained by the same method, was shown as perhaps the first of its kind and likely to be followed by views of other experiments, as of antimony and arsenic burning in chlorine; and it was suggested that photo-engravings of such pictures should soon replace the woodcuts now used in text-books.

The paper was illustrated by about seventy-five original and highly novel lantern views, many of which, by Dr. Levison, were shown for the first time.

Prof. Albert R. Leeds made remarks upon the paper, expressing his great pleasure and interest in the beautiful results presented, and his appreciation of the scientific and persevering character of Dr. Levison's work.

Similar remarks were made by the Chair.

February 17, 1890.

LECTURE EVENING.

The President, DR. NEWBERRY, in the chair.

About two hundred persons present.

Notice was given that in consequence of prospective absence from the city, PROF. R. W. RAYMOND would not be able to deliver his lecture in May, as announced, and that it had therefore been arranged to be given, instead, on the evening of March 3d.

The lecture announced for the present occasion was then delivered by DR. H. CARRINGTON BOLTON, on

FOUR WEEKS IN THE DESERT OF SINAI,

largely illustrated with projections of views taken by the lecturer during his tour in that region in the spring of 1889.

The thanks of the audience were unanimously voted to DR. BOLTON.

February 24, 1890.

ANNUAL MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty-six persons present.

The RECORDING SECRETARY made a verbal report, in which he stated that the membership of the Academy remained about the same as at the beginning of the year,—the additions balancing the losses by death, resignation, and removal;—that there had been abundance of material offered in the form of papers and communications for the meetings; and that the Public Lecture Course had been largely attended and highly successful.

The Secretary apologized for the informal character of his report, on the ground of his absence abroad during a considerable part of the year past.

The CORRESPONDING SECRETARY presented his report, as follows:—

NEW YORK, Feb. 24th, 1890.

To the New York Academy of Sciences:

I have the honor to report on our roll of

	Members
Honorary Members	46

including five additions during the year.

As the number is restricted to fifty, there are four vacancies yet to be filled.

Corresponding Members	323

Of the members on our roll last year, we have lost two during 1889, viz. :—Dr. George H. Cook, of New Brunswick, N. J.; and M. le Dr. Quesneville, of Paris, France.

The Academy is now in regular correspondence with 434 societies, libraries, and journals in all parts of the world, and exchanging publications with nearly all, with the exception of public libraries, colleges, etc.

The following is a list of localities :

United States	117	Norway	8
Canada	13	Sweden	7
Mexico	6	Russia	14
West Indies	2	Switzerland	12
Costa Rica	1	Portugal	4
South America	4	Spain	1
Great Britain	53	Italy	25
France	38	South Africa	1
Austro-Hungary	15	India	2
Roumania	1	Java	3
Germany	71	Mauritius	2
Belgium	10	Australia	11
Holland	9	New Zealand	1
Denmark	2	Japan	1

During the past year, there have been 13 accessions to this list, of societies, etc., hitherto not in exchange with us.

Respectfully submitted,

ALEXIS A. JULIEN,

Corresponding Secretary.

The TREASURER presented his report, as follows :—

THE NEW YORK ACADEMY OF SCIENCES IN ACCOUNT WITH HENRY DUDLEY, TREASURER.

February 25th, 1889, to February 24th, 1890.

DISBURSEMENTS.

DR.	For printing ANNALS, TRANSACTIONS, CONSTITUTION, etc		$971 23
	" salary of Editor of the same (half-year)		150 00
	" Publication Committee, printing, directing and mailing notices of meetings, etc		150 38
	" printing ballots, envelopes, stationery, etc		62 39
	" binding books for library		208 55
	" postage, expressage, messengers, wrapping publications, etc		139 50
	" engravings for publications		70 75
	" travelling expenses of lecturers		79 00
	" janitorial services		64 00
	" insurance, dues refunded, etc		30 00
	Balance in Second National Bank		856 96
			$2,782 71

RECEIPTS.

CR.	By Balance from last report		$402 91
	" interest on regular U. S. 4 per cent consols	152 00	
	" interest on coupon 4 per cent consols	12 00	
			164 00
	" sales of publications		28 30
	" five fellowship fees		50 00
	" twelve initiation fees		120 00
	" annual dues		2,005 00
	" cash		12 50
			$2,782 71

The following is the statement of securities on hand to date:—

U. S. Govt. 4 per cent consols, regular		$3,800 00
" " " " " coupons		300 00
Savings bank accounts:—		
General fund	$850 00	
Interest to January 1st, 1890	45 37	
Publication fund	620 00	
Interest to January 1st, 1890	38 80	1,554 17
		$5,654 17

Respectfully submitted,

HENRY DUDLEY, *Treasurer.*

February 24th, 1890.

[This report was subsequently examined and certified in every particular by JOHN H. HINTON, Chairman of the Finance Committee.]

REPORT OF THE LIBRARIAN.

NEW YORK, Feb. 24th, 1890.

The Librarian would respectfully submit the following report:—

The number of accessions of volumes, parts, and pamphlets, during the past year, has been 1,399.

The number of volumes bound has been

(1) By appropriation of $100 from the Academy	98
(2) By Columbia College	51
(3) In process of binding by Columbia College	211
	360

The number of bound volumes now on the shelves of the Library is 5,004.

The number of unbound volumes, and of tracts which might be bound into volumes, is estimated at 700. In addition to these, there are several hundred incomplete volumes.

A number of new exchanges have been effected during the past year, and the complete list of institutions in exchange is appended. This number could, by proper effort, be very considerably increased.

Accessions have been entered as received, in a book prepared for that purpose, and receipts, signed by the Librarian, sent for every part and volume.

Respectfully submitted,

N. L. BRITTON, *Librarian.*

The PUBLICATION COMMITTEE reported verbally through the Chairman, PROF. MARTIN, that Vol. IV. of the ANNALS had

been completed at the close of 1889, with the exception of the index number, which is yet to be issued ; that work had been begun on Vol. V., and Nos. 1, 2, and 3 were well advanced toward publication ; that Vol. VIII. of the TRANSACTIONS had been completed during the summer recess ; and that Vol. IX., for the present session-year, was in progress.

The transfer of the publication-office of the ANNALS from this city to Philadelphia, as recommended to the Committee and authorized by the Council last summer, had been carried out. Satisfactory arrangements had been made with the Collins Printing House at Philadelphia; and the new volume (V.) was being printed there, in work of fine grade, at a reduction of cost upon New York prices amounting to some twenty-five per cent. The experiment was regarded as highly successful.

All the reports thus presented were accepted unanimously, and ordered to be placed on file.

The PRESIDENT explained the rules regarding the Annual Election, the composition of the Council's ticket as required by the By-laws, and the liberty of any member to alter it, or to present different tickets, for the votes of the Society. He then appointed DR. LAUDY and Mr. F. E. GARRETSON to act as tellers.

As no name had been presented on the Council's list for the office of Librarian,—owing to an uncertainty at the time of its issue,—PROF. MARTIN nominated for that position CAPTAIN ANTHONY W. VOGDES, U. S. A.

During the preparation of the tellers' report, after collecting the votes, the following papers were read by title:—

I. A STUDY OF SOME LOUISIANA CANE-JUICES, SUGARS, AND MOLASSES.

BY F. G. WIECHMANN, PH.D.

II. A LIST OF STATE AND LOCAL FLORAS OF THE UNITED STATES AND CANADA.

BY N. L. BRITTON, PH.D.

These two papers are published, the first appended to the proceedings of this meeting, and the second in Vol. V. of the ANNALS.

Dr. Britton made a report of progress in behalf of the Committee on the Audubon Monument, describing briefly the several methods employed by the Committee to further the object sought, and the difficulty encountered in obtaining the desired amount. The Committee have now about $1,000 in bank, and some $700 more in available pledges. They will proceed to make further efforts, and endeavor to complete their work during the present session-year, *i.e.*, by the summer of 1890; and then a monument can be erected, if not such as was at first desired, at least suitable and creditable.

The report was accepted and the Committee continued.

The tellers reported fifteen ballots cast, and the regular ticket elected, with but a few scattering votes, as follows:—

President, John S. Newberry.

First Vice-President, Oliver P. Hubbard.

Second Vice-President, Seth Low.

Corresponding Secretary, Thomas L. Casey.

Recording Secretary, H. Carrington Bolton.

Treasurer, Henry Dudley.

Librarian, Anthony W. Vogdes.

Councillors, N. L. Britton, Charles F. Cox, A. A. Julien, D. S. Martin, J. K. Rees, J. J. Stevenson.

Curators, Geo. F. Kunz, Bashford Deane, Miss F. R. M. Hitchcock, F. H. J. Merrill, W. LeConte Stevens.

Finance Committee, John H. Hinton, H. G. Marquand, O. B. Potter.

On announcing the result of the vote, the President returned thanks to the Society for the compliment of his re-election.

The business of the evening having been completed, Mr. William L. Elseffer made the following remarks:—

Mr. President:—I would like to call the attention of the Academy briefly to the present anomalous high-water condition in the lower Mississippi River.

It is well known that the Ohio River furnishes the waters that cause the great floods in the lower Mississippi. But there has not been as yet this year any considerable flood in the Ohio, nor in any large tributary of the Mississippi River, to cause, under natural conditions, the present high stage of water at New Orleans and Vicksburg.

The gauges at these two points show an excessively high stage relative to that of the water at Cairo.

This morning, the water in the Mississippi at New Orleans was only 0.8 of a foot below the flood-mark of 1884.

The register at Vicksburg this morning was only 3.2 feet below the flood-mark of 1884.

The gauge at Cairo this morning registered 16.6 feet below the flood-mark of 1884. On the 7th of the present month, the water had declined at Cairo to a point 17.7 feet below the same flood-mark;—the average being 12.5 feet at Cairo during the 24 days of this month.

Had the former natural relativity obtained between Vicksburg and Cairo, the stage at Vicksburg would have been 8.5 feet lower than it stands to-day; and would also have indicated a decline of several feet, corresponding to the large decline at Cairo on February 7th.

But the Mississippi River at New Orleans and Vicksburg has shown a remarkable persistence of rise, going up day by day for the past 24 days.

The fact is, that the river is gorged from Helena to New Orleans, a distance of about 500 miles.

What would happen in the lower Mississippi valley, were a great rainfall to occur in the Ohio valley during the next two or three weeks, adding 16½ feet to the present stage at Cairo? Possibly a calamity of inundation that would startle the world.[1]

The PRESIDENT commented on the important and suggestive character of MR. ELSEFFER'S data and observations. If it be true, as would seem to be indicated, that the jetties at the mouth of the Mississippi are operating thus to retard its natural outflow, and involve danger of serious flooding, the fact is one that calls for grave consideration.

The paper announced for the evening was then read, as follows :—

SCIENTIFIC JOTTINGS ON THE NILE AND IN THE DESERT.

BY H. CARRINGTON BOLTON.

Several months ago, I read to the Academy a report of my researches on Sonorous Sand in the desert of Sinai (October 21st, 1889), and more recently I gave a popular account of the method of travel, scenes and incidents in the same region (February 17th, 1890). But on these occasions I presented only a part of the notes jotted down in my journal; these impressions and

[1] These observations have much interest in connection with subsequent events in that region.—ED.

observations recorded during a brief sojourn in the Nile Valley, and a more deliberate study of the desert, I have arranged in the following pages.

This paper is not, however, an essay on the meteorology, geology, and natural history of these countries; and it should be remembered that my experience is limited to a single visit and to a certain season of the year.

This period, and the distribution of my time, must be stated at the outset. Arriving in Cairo February 1st, 1889, I spent the first week of this month in Cairo, the second and third on the Nile, the fourth and the first two weeks of March again in Cairo and vicinity. I then entered the desert, March 13th, and four weeks later returned to Cairo for still a portion of a week, finally leaving Egypt on April 15th.

Temperature.—In discussing one's experience on a journey, it is natural to begin with the weather. In the earlier weeks named, the temperature at the hotel in Cairo ranged from 60° to 65° at 8 A.M. to 75° and 78° at 3 P.M., falling to 64° and 67° in the evening. In April it was appreciably warmer, but never oppressive in the shade. On the Nile steamer, however, greater extremes were noted; 54° at midnight (Feb. 19th) to 87° at 2.30 P.M. (Feb. 9th). The latter figure was exceptional and was regarded as oppressive. These figures give an impression of great extremes, but the changes in any period of 24 hours are not commonly very great. Luxor is attaining some reputation as a health-resort, on account of the equable temperature and dryness of the atmosphere. In the first three months of 1889, the average temperature out of doors at the hotel is thus given:

	9 A.M.	2 P.M.	6 P.M.
January	60°	68°	65°
February	60°	70°	68°
March	71°	81°	78°

Authorities state that, as a result of ten years' observations, the mean temperature in the Delta and at Cairo is 58° in winter, 83° in summer, and 66° in autumn; the lowest record in the Delta is 35°, the highest about 95° in the shade. In Upper Egypt, however, the temperature rises to 109°.

The temperatures that I noted in the desert of Sinai were taken at great differences of elevation, my route extending from the sea-level to the summit of Jebel Mousa, 7,400 feet high. I copy a few records from my journal.

In Plain of Shur (perhaps 50 ft. above sea-level).

March 13th	7.30 A.M.	59°	
"	3.00 P.M.	80°	in sun
"	8.30 P.M.	66°	

March 14th..... 7.00 A.M. 50°
" ..... 7.00 P.M. 70°
March 15th..... 7.00 A.M. 62°
" ..... 9.30 P.M. 75° (south wind)

In Wadi Feirân and beyond.

March 19th..... 6.30 A.M. 52° (rain)
" ..... 9.00 P.M. 52°

At Monastery of St. Catherine (5,000 *ft.*).

March 21st..... 8.00 A.M. 48°
" ..... 9.00 P.M. 55°
March 22d..... 6.30 A.M. 46°
" .....10.00 P.M. 56°
March 23d..... 8.00 A.M. 57°
" ..... 9.30 P.M. 60°
March 24th..... 7.00 A.M. 54°
" .....10.00 P.M. 62°
March 25th..... 7.30 A.M. 59°
" .....11.00 A.M. 72°
" .....10.30 P.M. 66°
March 26th..... 7.00 A.M. 62°
" ..... 9.00 P.M. 66°

Wadi Es-Sleh to Tor.

March 29th..... 6.00 A.M. (Wadi) 67° (1,500 ft.)
" ..... 3.00 P.M. (Tor) 88°
" .....10.00 P.M. (Tor) 75°

Summit of Jebel Mousa (7,400 *ft.*)

March 22d..... 9.30 A.M. in shade, 46°
" ..... " in sun, 70°

Camp on Gulf of Suez.

March 31st..... 9.00 A.M. in sun, 88°
" ..... " in shade, 72°

On Seetzen's Slope, Jebel Nagous.

March 31st.....11.00 A.M. in sun, 86°
" ..... " in shade, 72.5°
" ..... 2.00 P.M. in sun, 100.5°

The highest evening temperature was on March 17th, after the Khamsîn had blown all day,—at 7 P.M., 84°. The lowest temperature observed was on March 20th, in camp about 3,000

feet above the sea,—at 6.30 A.M., 33°. (In February, 1874, Rohlf noted in the Libyan desert a minimum temperature of 23°.)

In considering the physiological effects of these temperatures one must remember the extreme dryness of the atmosphere in the desert.

Rainfall.—My first experience in Egypt was calculated to give the impression that it is a rainy country, for I saw two showers in three days. In passing through the Suez Canal (January 31st), a heavy shower, lasting half an hour, drove the passengers to shelter, and a brilliant rainbow delighted beholders. Two days later, rain again fell at night in Cairo, making the dirty streets more nasty still. Of course this experience was exceptional, as rain is a rarity in Cairo. Authorities give the rainfall at Alexandria as about 8 inches per annum, and at Cairo about 1.2 inches; while in Upper Egypt the precipitation of moisture is far less: there are adults living there who say they have never seen rain.

I noticed, on the other hand, unmistakable signs of recent rains, such as dried mud-puddles, raindrop-prints, etc., at several points, near Cairo, east of Thebes (Wadi Bab-el-Molook), and in the peninsula of Sinai, and I was impressed with the belief that more rain falls in Egypt than is usually supposed. A local shower passing over a sandy, gravelly region, makes but little impress on it; and there is no corps of trained observers, outside of Cairo and Alexandria, to record the phenomenon. On visiting the Khedivial Astronomical Observatory just out of Cairo, I was cordially received by the Director, Mr. T. Esmatt, a graduate of the École Polytechnique of Paris, and for three years an assistant in the Naval Observatory at Washington. I take pleasure in mentioning his politeness and courtesy, but cannot omit pointing out a weakness; he took me to the roof of the building to see the meteorological instruments, and I noted that the rain-gauge was quite full of water; this again gave me reason to regard Egypt as a rainy country. (The last shower fell one month previously.)

Being on the lookout for signs of water in the desert of Sinai, I made the following notes:—The slight depressions in broad plains and the deep, narrow valleys in the hill country, both indiscriminately called wadis, present the appearance of dried-up water-courses; the signs are unmistakable,—a tortuous channel with vertical sides carved out of the gravelly bottom, pebbles and boulders transported from distant sources scattered over the surface, mud-flakes and mud-cracks in small bays, as it were, at the sides of the main channels. At two or three places on the sea-coast, extensive mud-flats were pitted with characteristic rain-

drop impressions. The line of the now arid water-course was often bordered by scanty and hardy shrubs.

Between March 13th and April 8th (1889) rain actually fell three times in my vicinity; twice the fall was insignificant, lasting only two or three minutes, but on March 19th rain fell abundantly in Wadi Feirân, from 7.15 A.M. to 9.30 A.M. Heavy mists had obscured the peaks bordering this extensive valley nearly all the preceding day; the temperature during this rainfall was 52°, elevation about 1,900 feet.

That heavy falls of rain and even of snow occur in December and January in the Sinai region, is reported by many travellers; in the defile of Nakb-el-Hawi (5,000 feet), crossed by pilgrims *en route* for the sacred mountain, the winter rains make veritable torrents; in 1867 the water rose to such a height in the valley adjoining, Wadi-Selâf, as to wash away a camp of Bedouins, causing a loss of 40 lives and of numerous cattle (Baedeker). Capt. Palmer describes also a sudden precipitation so copious as to fill the bottom of Wadi Feirân to the depth of several feet, causing the party to seek high ground. That the Oasis of Feirân was once the site of a village of anchorites and monks sufficiently important to become an Episcopal See, is known to students of history; this was in the second to the sixth century A.D. A few cut stones, the capital of one column, and ruined sites, alone remain to indicate the locality.

Judging by the great boulders and trunks of palms which I saw in the lower part of this valley, I am disposed to believe that heavy rains are more frequent than supposed. Casual and irregular observations of rainfall by travellers, who of necessity move their tents almost daily, and who choose favorable seasons for the journey, are of course unreliable data for scientific conclusions as to the meteorology of the country. Unfortunately, the monks residing at the Monastery of St. Catherine, and who enjoy great opportunities, care for none of these things.

Returning for a moment in thought to the Nile valley, I note that although the sun usually shines with great brilliancy, it is a mistake to infer that the sky is uniformly cloudless. In March there were many cloudy days, some of which would, in this country, have been regarded as rain-precursors.

Winds.—Powerful winds sweep across the plains and through the valleys of Arabia Petræa, with a violence and continuity that I have not elsewhere experienced. In the spring months the prevailing wind in the desert is from the north and northwest, down the Gulf. This wind is a cool one, but it occasionally veers around to the south and becomes oppressively hot. In April and May this south wind, called *Khamsin*, blows unremittingly for days together, scorching the traveller's skin

and filling the orifices in his head with a very fine dry dust. Khamsîn is from an Arabic word meaning fifty, so called from a mistaken notion that it blows for a period of fifty days before the summer solstice.

In the Nile valley, north winds prevail during the heated period of eight months, and southern winds during the rest of the year; these being in the opposite direction from the winds in the region of the Red Sea.

Sand-storms.—I witnessed three characteristic sand-storms at localities far apart and under varied circumstances. On February 15th, when riding a donkey through Thebes Nileward, a powerful west wind arose in the afternoon, blowing before it fine dust from the Libyan desert. Words fail to describe the discomfort of such a sand-storm; the fine dust seems able to penetrate everything except perhaps an unbroken egg, and it is quite impossible to escape from it; to prevent suffocation, I borrowed from a fellah a coarse yet closely-woven blue outer garment and wrapped my head up. Donkeys did not seem to enjoy the phenomenon any better than the Bedouins, and they shrunk from its blast as well as the travellers. On reaching the river, we alighted, but found the waves so high that boats could not cross to take us over, and we had to wait in patience until the force of the wind was spent. I tried lying down on the shelving shore, but the coarser grains of sand driven near the surface cut into the skin with painful effects. After crossing to Luxor in a boat, we found the residents in the large hotel much inconvenienced by the penetrating dust, although the building is screened by a handsome garden.

My second experience was in Cairo itself. On March 6th a northwest, and consequently a cool, wind blew dust from the adjoining desert into the city with such power as to obscure the usually brilliant sun during an entire day. The barometer fell 0.46 inch at the time, and the thermometer indicated 66° at 8.30 A.M. and 67° at 10.30 P.M. Residents of Cairo said that the sand-storm was the severest in twenty-five years, and of an unusual character,—being accompanied by a low temperature instead of the scorching Khamsîn. The following day was clear and cool. The dust penetrated every cranny and gave hotel servants hours of labor.

I experienced a third sand-storm in the desert of Sinai, on the plain of El Markha; it was accompanied by a scorching south wind, and the drying effects on the skin and the capital orifices produced greater discomfort than the suffocating dust and cutting sand; my party could do nothing but sit in silence on our camels, facing the storm, and the poor animals forgot to snatch at the tufts of scanty shrubs, as is their custom. After

crossing the plain, we entered a defile and rose to a considerable height on the Nakb-el-Budra; the sand-storm continued, quite spoiling our enjoyment of the wild scenery and making photography impossible. In the evening the fierce wind very nearly overturned our tents in spite of extra stays, and at dinner every course was seasoned with the all-penetrating dust. The temperature at 7 P.M. was abnormally high, 84°; just twenty-four hours later it had fallen to 58°, the wind having meanwhile veered around to the north, bringing with it heavy mists.

The manner in which sand is driven up the slope of Jebel Nagous by the wind from the Gulf, I have described elsewhere (TRANS. N. Y. ACAD. SCI., IX., 21).

A single instance of electrical display was observed on March 26th, while in camp at Sinai. My companion, Henry A. Sim, Esq., of the Madras Civil Service, while lying in the tent, drew bright sparks from the woollen blankets by friction; the temperature without was about 64°.

Before dismissing the subject of climate, I wish to testify to the invigorating, delightful air in the desert; it has a bracing quality that enables one to expend much energy without fatigue. From about 1 to 3 P.M. the glare of the sun is often great, and shade is a comfort; but the constant breeze, sometimes rather too strong, tempers the heat. I suspect, too, that the air is very free from disease-germs.

Of the dreaded Khamsîn, however, I can say nothing favorable.

Physical Geography.—Reminding you that this is a record of experiences and impressions, and not an essay on meteorology, geology, etc., I shall not repeat familiar descriptions of the wonderful Nile valley; the views shown in connection with this will illustrate certain features.

I made several excursions in the neighborhood of Cairo; on the west lies the river, and across the bridges cultivated fields so far as irrigated; beyond that the Libyan desert. On the east the quick transition from the streets of a city, swarming with 400,000 inhabitants, to the sterile desert, is very striking; passing through an arched gateway, and by some sorry-looking Mohammedan burying-places, one immediately finds himself on gravelly, undulating plains, devoid of water and foliage, extending in monotonous uniformity to the Gulf of Suez, about 80 miles distant. Jebel Mokattam, a limestone range on the south, rises nearly 500 feet above the city; my aneroid gave the elevation of the highest point overlooking Cairo as 694 feet above the sea-level, or 485 feet above Shepheard's Hotel. The desert, broken occasionally by low ranges of hills, has a hard gravel and pebble floor, chiefly limestone with fragments of

silex in the form of brown flint and chalcedony. Loose sand lies only in hollows between hillocks, the tops of which are wind-blown and bare. On the surface at certain points lie fragments of fossil wood, and rarely half-buried trunks of the same; it is dignified by the name "Petrified Forest." Some of this fossil wood proves to be good phonolite. (Specimen exhibited.)

I noticed here again evidences of water-courses, recent mud-flakes, etc. At the time of my visit the customary strong cool breeze prevailed, and the temperature was 74° in the shade at noon (March 8th).

On February 16th I visited a wild valley west of Thebes, known as Wadi Bab-el-Molook, celebrated for the numerous and well-preserved Tombs of the Kings, of great interest to archæologists. My experience and impressions of this arid region, written out on the spot, were as follows:—

Passing from the river bank through green cultivated fields of the Nile basin, the sterile, gravelly desert begins abruptly, the sudden transition being determined by the irrigating canals and channels. At the mouth of the valley, about two miles from the Nile, the scene is one of utter desolation; absolutely no vegetation of any description is visible, not a dry lichen nor a gray shrub. Beneath the feet is a hard gravelly floor, grayish-white in color, consisting of broken and powdered limestone from the neighborhood, intermingled with nodules and pebbles of silex. True flint, from white to liver-brown in color, and having characteristic conchoidal fracture, is abundant. The silex commonly takes the concretionary form, some of the shell-like and ring-shaped masses reminding one of fossils. But little sand is present.

At the entrance of the valley the hills rise at a gentle slope, their sides being here and there dotted with large masses of limestone with a firm cement, or rather with seams, of dark-colored quartz. The strata, as seen by the unaided eye, appear to be horizontal. The rock has a shaly character in places, being deeply weather-eaten, friable, and soft. Ascending the valley, a spur divides it into two converging ravines; following the longer one to the west, the walls of limestone become precipitous, the quartzitic masses larger, and the general aspect wilder. At some places the limestone runs into chalk; this is especially well seen on entering one of the numerous Tombs of the Kings, the inclined passages penetrating hundreds of feet into the heart of the mountains.

The valley terminates in a *cul-de-sac*, about half a mile from its mouth, forming an amphitheatre of nearly vertical walls apparently 200 feet high, above which rise steep slopes perhaps

500 feet higher. These vertical walls are split by vertical joints into broad or narrow columns, making picturesque features.

Before I entered this valley, an untrained observer had enthusiastically informed me that it was full of fossils and the limestone stood in vertical strata ; the fossils prove to be concretions, and the strata, joints.

The valley throughout shows that water has at some time been energetically at work ; the floor resembles a dried-up mountain torrent; banks of gravel, sand, and boulders rise several feet above the bridle-path on each side; and at the lowest part, small channels wind about the large rocks. The hillsides are furrowed by ravines excavated by water. Here and there in low places, usually at the foot of a large boulder, are unmistakable signs of recently-formed mud. The scales and mud-cracks were quite fresh and seemed to indicate that water had accumulated in pools not more than two or three weeks before. On my return to Luxor, I was informed that rain had fallen about three weeks before (February 16th).

A sharp peak rises high above the walls of the amphitheatre referred to ; on the slopes of this peak several parallel bands of horizontal limestone differ in compactness, the softer wears away rapidly and the harder projects over the shaly inclines.

Climbing up a steep path and crossing the narrow ridge through a slight depression, I descended into the valley of the Nile ; limestone passed into shale, and this into cultivated ground. The numerous excavations of small tombs, the grand ruins of the Ramesium and of Medinet Haboo, with the solitary Colossi standing like sentinels on the plain, now drew off my attention from the geological features of the region.

Of the method of travel in the desert of Sinai, and of the incidents in my journey, I have spoken on another occasion. The physical geography of the region is rarely represented with accuracy on published maps ; Sinai often appears as an isolated peak, or at most as a detached group of mountains, whereas the whole peninsula is covered with sterile hills and clusters of mountains, except on the borders of the three seas by which it is bounded. The best maps known to me are those published by the Ordnance Survey, and by the Admiralty of Great Britain ; these seem to be topographically complete, but Jebel Nagous is not shown with accuracy. My own observations were limited to the following route :—from Suez to Sinai by the usual caravan route through Wadi Feirân, thence through Wadi Es-Sleh to Tor on the Gulf, and back to Suez by the usual route along the sea-coast, a distance of about 380 miles. The region, which is about the size of New Hampshire, contains within its boundaries three marked features :—comparatively level plains,

low ranges of limestone and sandstone hills, and an irregular group of bold granitic mountains whose peaks rise to the height of 8,000 feet. Each of these regions is furrowed by wadis, or dry water-courses, which present very different aspects in the three divisions named. In passing from Suez to Sinai, by the usual route, one meets these features in the order named.

Plains.—The first 52 miles of the journey, occupying about two days and a half, as camels travel, passes over an arid, sterile plain about ten miles wide from the low range of limestone hills on the east, Et Tîh, to the Gulf on the west. This plain, like that of El Gâa, to the south, rises gradually from the sea to the foothills, and is undulating towards its southern end. It is crossed by broad, shallow wadis, running east and west, which were perfectly dry at the time of my visit; Wadi Werdân, the largest, is depressed but a foot or two below the level of the plain and is approximately three miles in width at about six miles from the point where it enters the sea.

The most extensive plain on the western side of the Peninsula is that of El Gâa, which is about 80 miles long and 15 wide at its widest point. From the sea-coast to the mountains bordering it on the east, it rises nearly 1,000 feet, but so gradually as to deceive the eye and appear level. It is crossed by many shallow wadis, and its northern half is separated from the sea by a range of limestone hills (Jebel-el-Araba) reaching a height of 1,600 feet. When the plain was covered by the sea, this range was probably an island, or series of islands. The plain is rarely broken by hills, the sharp-pointed Krên Utûd, conspicuous from a distance, being an exception. I crossed the monotonous desolate waste, from the mouth of the beautiful Wadi Es-Sleh to Tor (or Tûr), on the Gulf, a distance of about 15 miles, and noted scarcely a dozen tufts of plants; water is absolutely wanting. North of Tor, however, and east of Jebel-el-Araba, are palm-gardens that extend for several miles in a narrow belt; and these date-bearing trees owe their existence to several saline springs occurring at intervals, some of which are quite warm. On this sterile plain, the characteristics of a desert are seen in perfection; the level expanse is not too broad to conceal the lofty mountains on the east, nor to prevent glimpses of the blue sea on the western horizon; the floor is a firm hard surface, made up of a compact mixture of gravel and coarse sand, so hard indeed that camels make no impress on it with their broad feet. At some places the surface pebbles are of many shades of brown, intermingled with black and white, and these are so closely laid and regularly distributed as to resemble a mosaic pavement, but of course a patternless one. The surface particles are generally coarser than those immediately beneath; they are chiefly limestone,

sometimes of coralline limestone, intermingled with flint and other varieties of amorphous quartz. Many of the pebbles show on their surface beautifully regular pittings and furrows carved out by the wind-driven sand. (Specimens shown.) The fine-grained sand has all been lifted high in air by the powerful winds, whirled away and dropped into depressions or on the lee sides of hills. Hundreds of acres have no surface stones larger than an ostrich-egg; no water whatever is found in this region, much less any signs of vegetable or animal life, rarely even a passing bird.

On this desolate plain, when overtaken by night, one place is as good (or bad) as another for pitching the tents, unless perhaps a small hillock is reached which may serve as a partial shelter from the gales that sometimes threaten to overturn the canvas.

Wadis.—In the region of extensive plains, the wadis, or dried-up water-courses, being depressed but little, closely resemble them. The floor of the wadi hardly differs from that of the plain, except when a torrent has swept before it large boulders and deposited them irregularly in its bed. The sorting power of the water, however, is noticeable, as also the well-defined vertical walls, perhaps only a few inches deep, excavated at the point of lowest level. On the margins, too, of the wadis of the plain, and at points protected from the full force of the winter floods, several varieties of green shrubs grow in widely separated tufts. I often remarked mud-cracks, apparently of recent date; but these indications of water probably remain undisturbed in this desolate region for a considerable period, perhaps for several seasons.

In the limestone hills these wadis take the form of cañons, having nearly vertical walls, sometimes hundreds of feet high, —as in Wadi Tayyibeh. The regular erosion on their sides produces often picturesque effects, as at Ras Abu Zanimeh.

In the granitic district the wadis form V-shaped valleys broken by narrower ones entering at right angles, and bounded by bold peaks many thousand feet above the beholder. In the beds of these wadis are scattered specimens of the rocks of the surrounding country; often boulders of great size testify to the violence of the torrents during the winter months, especially in Wadi Feirân. (Specimens exhibited.)

Water.—The absolute dependence of the population of Egypt upon the Nile is a familiar fact, discussed from the time of Herodotus to the present day. The proposed re-opening of Lake Mœris in the Fayoum district, for irrigating the Delta, has been fully explained to the Academy by one of our members, Mr. F. Cope Whitehouse, its enthusiastic advocate.

The conditions of occurrence of water in the desert are perhaps less familiar. Not only is water scarce, but when obtained a large proportion of it is practically unpotable, being saturated with saline matter to such an extent that the soil in the vicinity is white with efflorescent salts of soda, magnesia, and lime. The "bitter waters" of Marah are not exceptional. The longest journey that I made without meeting good drinking-water was on the return from Tor to Suez, a distance of about 150 miles, occupying six-and-a-half days. On this route we passed a well in Wadi Gharundel where camels and Bedouins slaked their thirst, and our water-barrel was replenished with water for washing; but had we not been supplied with sweet water from the Nile, brought down to Tor on a boat from Suez, we should have fared badly in this respect. At the time of my visit, all wells were admittedly very low, and in some places entirely dried up; so I saw the region in its most arid aspect.

Good water, flowing from springs and running short distances, —say a quarter of a mile before sinking into the thirsty soil,— is found in Wadi Feirân and in Wadi Tarfa. In the former place, many date-palms and even barley-fields make a charming oasis; at the latter, palms, canes, and tamarisks line the babbling brook, as it may truly be named, but the oasis is not extensive. North of Tor, on the Gulf, are flowing springs of warm and saline water, not very palatable, but admirably adapted to the culture of date-palms, of which there are many thousand. The best drinking-water in the region that I visited is on the flanks of Sinai; there are four wells within the monastery walls, one without, and others in the Leja valley and vicinity.

The warm saline spring at the foot of Jebel Hammam Mousa, mentioned in my paper on "Sonorous Sand" (read October 21st, 1889), is described by several travellers as sulphurous; but at the time of my visit it was assuredly devoid of the characteristic taste and smell of sulphuretted hydrogen. Its temperature is 92°–94°, and it is strongly saline.

Hot springs issue from caverns filled with steam at the base of Jebel Hammam Farûn, a mountain of crystalline limestone on the Gulf of Suez. These are described by Russegger, who says the vapor had a sulphurous smell and the walls of the caverns were encrusted with sulphur. The saline water has a temperature of 153° and is used by the Bedouins for curative purposes.

In Wadi Es-Sleh, the romantic gorge southwest from Sinai, I discovered a cold and sweet sulphur spring, agreeable to the palate. It issues in the centre of the wadi, at a point two hours' journey east of its mouth, and flows a short distance, depositing characteristic bluish sulphur on its borders; it was

this latter that first attracted my attention. This spring is not mentioned in Baedeker's guide-book, generally so accurate.

The total absence of ponds and lakes is a marked feature in the physical geography of the peninsula of Sinai; rain does at times fall in abundance, but it rushes precipitately down the wadis into the seas which bound it on two sides. Yet there is evidence of the existence of lakes at some earlier period; in Wadi Feirân, banks of earth 60 to 100 feet high rest on the mountain-sides, especially in the angles of the valley, showing clearly the former existence of a lake, the barrier of which was probably near Hererât. I noticed also at the point where the Wadi Es-Sleh enters the plain of El Gâa, unmistakable signs of an ancient lake; the wadi emerges suddenly from the mountain range, and a circular depression from 30 to 50 feet deep, with a perfectly level sandy bottom, and bounded by nearly vertical gravel cliffs, now marks the bed of a small lake.

The uninhabitability of the Peninsula is due to its sterility rather than to its climate; its sterility is due, I imagine, more to the unequal annual distribution of the water, than to its absence, and should the population warrant it, storage-dams, easily constructed in the narrow granite-walled wadis, would to a great degree remedy this defect. Perhaps at some future day, when a crowded world thrusts its surplus population into regions now hardly regarded as habitable, Arabia Petræa will bloom like a garden. Granite and limestone furnish valuable soil-ingredients, and the climate is not unfavorable to semi-tropical cultivation.

We make brief allusion to the admirable porous earthenware kullehs manufactured on the Nile, and familar to all Eastern travellers. The extent to which evaporation from the surface cools the contents is notable; at 11 A.M. the temperature of the air in the shade was 72°, and of the water in a goglet (kulleh) only 53°,—a difference of 19 degrees. During the cold nights, the water in our barrels fell to a low temperature, so that it was agreeable to the palate. A party of Americans who ascended Jebel Katharine, while I was camping at Sinai, reported finding ice near the summit in a shady ravine, and enjoyed the luxury of iced water.

Geological Note.—The geology of Egypt and of the Peninsula has been described by Fraas, Holland, Hull, Palmer, Zittel, Schweinfurth, and others, in publications accessible to those interested. Fraas says of the Mt. Sinai group: "This huge range, composed of primeval gneiss and granite, has undergone no geological change since the time of formation of these crystalline masses; they have reared their majestic summits above the ocean from the beginning of time, unaffected by the transitions of the

Silurian or Devonian, the Triassic or chalk periods." At the base only do these venerable mountains show any trace of alteration; thus the Red Sea has on one side thrown a girdle of coral around Mt. Sinai, and so in recent times produced a coast district; while towards the north the sea during the Cretaceous period has formed the limestone plateau of Et Tîh (4,000 feet above sea-level), which stretches across the Peninsula to Mt. Lebanon.

A very remarkable feature, that does not escape the most careless observer, is the variety and beauty of the colors of the rocks; in the limestone region every imaginable shade of yellow, red, brown, and gray, besides snow-white and quite black, give the barren cliffs a picturesque appearance which photography unfortunately fails to reproduce; in the granite region this gray crystalline rock is traversed in all directions by dikes of eruptive diorite, varying in color from black to green and brick-red. In Wadi Tarfa I counted nine narrow red and green dikes in a space of twelve feet. Elsewhere the dikes varied in width from two inches to thirty feet and more; sometimes the red porphyry traversed the green, and sometimes both lined the same fissure in the granite. The colors are as well-defined as those on a geological map, and combining with the strong atmospheric coloring of an almost cloudless sky, that produces bright lights and deep shadows in the foreground and an indefinable haze on the distant mountains, together with the deep blue of the mis-named Red Sea, produce an incomparably artistic effect. (Specimens of red and green diorite.)

Sand.—The main object of my journey being a search for sonorous sand, my attention was naturally directed to the occurrence of sand in general. Large banks of blown sand are characteristic features in the Nile valley, in the Libyan desert, and in the Peninsula. On the railroad from Ismailiya to Cairo, the authorities have found it necessary to construct long barricades, like our snow-fences, to prevent the drifting sand from burying the track out of sight. In the Nile valley, the fine and dry sand has kindly done great service to archæologists; blown into underground galleries used for sepulture, it has preserved intact the artistically decorated walls. Opposite Assouan, Sir Francis Grenfell has recently opened a score of tombs in which the paintings are as brilliant in color and polish as when completed by the Egyptian workmen centuries before.

As already intimated, loose sand into which the feet sink is confined to the bottom of deep wadis (Tarfa, Es-Sleh, etc.) inaccessible to high winds, and to banks resting on comparatively level expanses (Gizeh, Ismailiya, etc.) or on the flanks of hills (Jebel Nagous, etc.). In Wadi Feirân, near its entrance

into the Gulf of Suez, I noticed a prodigious bank of blown sand, with a rounded summit and regular outline, estimated to be 200 feet high. The bank of sand called Seetzen's Slope at Jebel Nagous, rests on the hillside to the height of nearly 400 feet. This I have described elsewhere (TRANS. N. Y. ACAD. SCI., IX., 21). The dunes immediately on the sea are comparatively insignificant, eight to twelve feet high at the points reached on my route.

The phenomena of sonorous sand at Jebel Nagous, and my discovery of a new locality (Ojrât Ramadân), have been fully presented to the Academy. On my return to Egypt, I made a careful examination of lofty and steep dunes near Ismailiya, notes of which I take from my journal.

On the southern borders of Lake Timsah (an adjunct of the Suez Canal), a series of dunes extends for more than three miles; some of them rising to the height of 100 feet. At a point about three miles from Ismailiya, between the lake and a shallow lagoon separating it from the desert to the south, the north and south winds meet in an eddy, blowing up the fine yellowish sand in steep slopes terminating in a long knife-edge ridge. On the steepest inclines the sand has the mobility observed at other localities; there were signs of spontaneous movement down the slope. I tested this sand at several places, two being a mile apart; but all my efforts to coax sound out of the moving sand were futile. The sand beneath the surface was not so dry as that observed in the desert.

The dunes are quite without structure; the sand is uniform in grain and color from the very edge of the lake up over the top of the ridge. No shrubs or blades of grass find foothold on the arid slope; the surface is everywhere marked by wind-furrows except where obliterated by the spontaneous sliding mentioned. (Specimens.)

The abrading and sculpturing by wind-driven sand may be seen to great advantage in many places; on the Nile, inscriptions on granite temples and obelisks are sadly defaced where exposed to this agent; and in the desert most picturesque effects are seen, especially in the sandstone region, as on the defile called Nakb-el-Budra, and on Jebel Nagous. On the plains, surface pebbles show a delicate pitting and furrowing caused by the sand-blast. This is noticeable not only on soft gypsum and limestone pebbles, but even on crystalline quartz. (Specimens.)

Minerals.—Mineralogically the Peninsula is very poor. I collected at different points snowy gypsum, fair selenite in imperfect crystals, and massive white chalk, and noted thin streaks of epidote, small garnets, and quartz crystals. The turquoise-mines of Maghâra, which were worked under the Pha-

raohs, and reopened by Major Macdonald in 1863, are now entirely abandoned. Bedouins offer for sale to tourists poor specimens found in Wadi Feirân and elsewhere.

Near Sarbût-el-Khâdem (which I did not visit) are ancient copper-mines; the ore is described by Rüppell as an earthy oxide and is not entirely exhausted, though no longer exploited. In the plain of Er Raha is a "dark green spot in which antimony is probably to be found," but this statement of Baedeker I cannot verify.

The flora and fauna of the desert have been often described, yet I imagine that much remains to be studied. Again reminding you that this paper is a mere record of my impressions, and confessing my ignorance of the science of botany, the variety, beauty, and fragrance of the shrubs and flowers which the traveller meets in the most forbidding and unexpected spots, were to my unprepared mind a remarkable feature. In March I gathered dandelions and daisies at Wadi Useit, also "butter and eggs"; in Wadi Tayyibeh near saline water, spearmint; and in Wadi Feirân, on the hillsides, sorrel.

The oases with their date-palms, tarfa (or tamarisk) yielding manna, seyâl (or acacia) yielding gum-arabic, gharkad shrubs, and thickets of tall reeds, are veritable islands of fertility in an ocean of desolation. At the Monastery cypresses, oranges, peaches, and vines are cultivated, although 5,000 feet above the sea-level.

Naturalists enumerate a number of large animals that live in the oases of the desert, among them the gazelle, ibex, jackal, and fox. I met with the head of a gazelle and numerous horns of ibexes, and in Wadi Es-Sleh a Bedouin suddenly appeared with two little half-tamed ibexes about fourteen days old; my travelling companion bought them, but they were unable to withstand the novelty of camel-riding, and though kindly cared for, died within a few days. Their skins were preserved. I noted on the journey a large field-mouse, a small light yellow snake 2½ feet long, and a peculiar kind of a lizard (?) At Assouan I killed an intensely energetic scorpion, and at many places noted chameleons basking in the sun. Of the numerous and curious fish in the Red Sea, I can only say that some of them proved to be excellent food.

Insects were rarely seen in the desert, and only in the neighborhood of water, or in the oases. I observed red and black ants, one large caterpillar, very few flies, many black beetles leaving behind them well-defined tracks as they crawled over the fine-grained sand, a few moths, a bee, a grasshopper, many spiders, a ladybug (so-called), gnats near the sea-coast, and my travelling companion noted fleas. Mosquitoes, so abundant in

Cairo, were not seen nor heard. Twice large birds sailed high above our heads. This is the total of animal life met with in my four weeks' journey, excepting camels, goats, one lamb (which we ate), one donkey (at Tor), a dozen cats (at the Monastery), several Bedouins, two Russian ladies, two German philologists, two Irish theologians, three enterprising Americans, and twenty-nine lazy monks.

Note.—The specimens exhibited included:—syenite, chalcedony, nummulitic and compact limestone, Gizeh ; alluvium from banks of Nile above Luxor ; salt conglomerate, Thebes ; syenite, quarries of Syene ; limestone, Wadi Bab-el-Molook ; fossil wood (phonolite) from near Cairo. Also from the Peninsula of Sinai :—chalk, snowy gypsum, selenite and sculptured pebbles, Wadi Amara ; red porphyry, Wadi Rahabah ; turquoises, red and green porphyry, Wadi Feirân ; gravel and sand from surface of Wadi El Ahatta ; silicious iron concretions, Nakb-el-Budra; fossiliferous sandstone, Jebel Hammam Mousa; granite, quartz crystals, dendrite, Jebel Mousa (Sinai); red coral and coral limestone, Gulf of Suez near Tor; white sandstone, amorphous quartz, Jebel Nagous ; winnowed sand and pebbles, plain at the foot of Jebel Nagous ; gypsum and conglomerate, Ojrât Ramadân ; and a collection of blown sands from many localities in Egypt and Arabia Petræa. The lantern views from original photographs comprised scenes on the Nile, views of the cliffs, Wadi Bab-el-Molook, quarries of Syene, granite hills near Philæ, Wilderness of Shur, Wadi Tayyibeh, blown sand on Ojrât Ramadân and El Gâa, Wadi Es-Sleh, and the Esbekiyeh Gardens, Cairo.

March 3, 1890.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

About two hundred persons present.

The minutes of February 24th were read and approved.

The report of the COUNCIL was read, recommending:—

I. The payment of the following bills:

Publication of ANNALS, Vol. V., Nos. 1, 2, and 3,	$242.49
Editor of publications (one-half year),	150.00
Minor expenses,	18.32

II. An appropriation of $100 for the chairman of the Publication Committee for his services for one year, 100.00

III. The election as Resident Members of

MR. R. HUDSON RILEY,
MR. LORENZO DOW,
DR. H. T. VULTÉ.

IV. The election of

PROF. JOSEF SZABÒ,

of Buda-Pesth, Hungary, as Honorary Member.

The recommendations were approved by vote of the Academy, and the persons named elected as specified.

The following Committees have been formed by the Council:—

On Publications: D. S. MARTIN, chairman; H. CARRINGTON BOLTON, J. S. NEWBERRY, J. K. REES, T. L. CASEY.

On Nominations: The entire COUNCIL.

On Library: N. L. BRITTON, chairman; A. A. JULIEN, C. F. COX, J. S. NEWBERRY.

The fifth lecture of the Public Course was then delivered, entitled

THE GRAND CAÑON OF THE COLORADO.

BY PROF. R. W. RAYMOND, PH.D.

The lecture was fully illustrated by projections of original photographs. At the conclusion of the lecture, a vote of thanks was unanimously given to PROF. RAYMOND for his interesting discourse.

March 10, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About thirty persons present.

The minutes of March 3d were read and approved.

The following gentlemen were elected Corresponding Members:

S. KULIBIN, St. Petersburg, Russia.
N. KULIBIN, St. Petersburg, Russia.
COL. LAUSSEDAT, Paris, France.
ANTONIO DEL CASTILLO, Mexico City.
DR. A. B. MEYER, Dresden.
H. D. HOSKOLD, Buenos Ayres, S. A.
LADISLAU NETTO, Rio Janeiro, S. A.
ALFRED LACROIX, Paris, France.

President NEWBERRY made some interesting statements in regard to the cost of illustrating scientific articles, and exhibited specimens of photo-engravings which could be produced at a moderate expense.

MR. JONATHAN DWIGHT, JR., read a paper entitled

GEOGRAPHICAL VARIATIONS IN THE HORNED LARKS OF NORTH AMERICA.

(Abstract.)

The object of the paper was to illustrate how beautifully the theory of geographical variation is supported in a group of birds known as the Horned Larks, which are found over the whole country from the Atlantic to the Pacific, and from the Arctic

regions down into Mexico and even as far south as the United States of Colombia. They are now considered to be all of one species, divided into a number of sub-species, also called geographical races or varieties, which intergrade one with another, but are distinguishable by size and coloration, these conditions being imposed by climatic influences upon birds inhabiting different areas. These differences, which are observable in many other groups, may be summed up, in a general way, as paleness in birds of desert or boreal regions, and darker, brighter colors in birds of southern regions or those of heavy rainfall; greater size in birds of Arctic distribution, and less size in birds of southern latitudes; but there are often combinations of altitude (which corresponds to Arctic distribution) and of local desert or forest influences, which tend to confuse the general principle just enunciated.

It is not many years since birds obtained in different parts of our country were described as distinct species; these have since been found to be simply geographical races of the same species. Connecting links have been obtained from intermediate areas, and the chain is complete, no matter how much the ends may differ. We have such a chain in the horned larks. How this came to be gradually recognized may be best shown by a brief history of the species.

In 1831, the name "Lark," applied by Catesby to the bird found in the Carolinas, was the first of a long list of names, both scientific and vernacular, applied by later writers to this species, which can boast of as many synonyms as almost any other of the unfortunate species that have received like treatment at the hands of professional and unprofessional ornithologists. In 1758, Linnæus gave to Catesby's "Lark" the name *Alauda alpestris,* the first binomial applied to the bird. In 1828, Boie separated the genus *Eremophila* from *Alauda* (the true skylark), and our bird became *Eremophila alpestris.* In 1839. Bonaparte substituted the name *Otocoris alpestris* (*Eremophila* being preoccupied), under which name was included the bird inhabiting the northern parts of the Old World as well as nearly all North America. This is the name in use to-day, although many others have had more or less currency. In 1858, Baird referred all the North American horned larks to the species *cornuta,* ranking *chrysolæma,* which was described in 1831 as a species by Wagler, as a sub-species. Here we have the entering wedge of trinomialism among the birds; and the subspecies *leucolæma* was added by Coues in 1874, at a time when the propriety of indicating geographical races by the addition of a sub-specific or third name had become almost a necessity in ornithology. The scientists of our great country have recog-

nized this need long before those of the Old World ; and consequently trinomialism is considered largely an American idea, or rather its application has been more general on this side of the ocean than elsewhere. The future may have in store better methods of providing recognition for geographical races ; but at present trinomialism is certainly the only method which attains this purpose. By means of an intelligent nomenclature, we are able to express the relation that existing forms bear to their neighbors, as well as to their ancestors ; and according to the amount of material studied, these relations become clearer. Coues in 1874 recognized three forms of the horned lark, and in Baird, Brewer, and Ridgway's "History of North American Birds," published in the same year, the three were practically recognized,—this conclusion being the result of the examination of over 100 specimens from all parts of the country. In 1884, Mr. H. W. Henshaw examined about 350 specimens, and ventured to divide them into eight sub-species.

During the past winter the writer of the present review of the genus has examined over 2,000 specimens, and his conclusions form a paper, already in press, which takes up the subject at this point, and was read in part only, the technical portions being omitted. It was illustrated, however, by a wall-map showing the breeding area occupied by each of the races, and by a selected series of specimens from each of the areas, which showed typical birds, male, female, and young, in spring and autumn plumage.

This series had been selected from the 2,000 examined, probably the largest number of one species ever before brought together. The study of this extensive series developed two new facts, so far as this species is concerned, in regard to plumage;—the first, that but one moult takes place in the year, the breeding plumage being the result of the wearing away of the tips of the feathers acquired during the autumn moult; and the second, that young birds in passing from first plumage moult *all* their feathers, including wings and tail.

In establishing sub-species, the following rule was applied, viz., to recognize as races groups of birds that during the breeding season occupy definable areas over which similar conditions of climate and vegetation prevail, and that show differences of size or plumage at the centres of such areas, which may be readily recognized and clearly described. This brings it down to a question of how closely to draw the circumscribing lines ; and allowing the already described forms to stand as models, eleven such races are admitted, three new ones being added to Mr. Henshaw's list. One of these has been separated by Mr. C. H. Townsend. Full discussion of these, with mea-

surements, lists of localities, map, etc., may be found in the *Auk*, Vol. VII., 1890, pp. 138–158 ; so that attention is merely called to them here.

The immense number of specimens gathered together represents nearly all the material extant on this side of the Atlantic, and more than half of them were sent to the last meeting of the American Ornithologists' Union by request of the Committee of Arrangements.

The races now recognized are as follows:—

1. Otocoris alpestris (*Linn.*).
2. Otocoris alpestris leucolæma (*Coues*).
3. Otocoris alpestris praticola *Hensh.*
4. Otocoris alpestris giraudi *Hensh.*
5. Otocoris alpestris arenicola *Hensh.*
6. Otocoris alpestris adusta *Dwight.*
7. Otocoris alpestris chrysolæma (*Wagl.*).
8. Otocoris alpestris rubea *Hensh.*
9. Otocoris alpestris strigata *Hensh.*
10. Otocoris alpestris merrilli *Dwight.*
11. Otocoris alpestris pallida *Townsend.*

It is hoped that this contribution to the knowledge of this species only outlines what may be better done in the future with many other widely distributed birds which are equally subjected to the influences of geographical environment.

ON THE GENUS ORACANTHUS AGASSIZ.

BY J. S. NEWBERRY.

(Abstract.)

Among the great number of defensive fin-spines of sharks which have been found fossil, the largest and most remarkable are those that are included in the genus *Oracanthus*. Some of these are of enormous size; the largest known, *Oracanthus grandis* Davis, being more than two and a half feet long by six inches in diameter at base. *Oracanthus Milleri* Agassiz is but little smaller.

The generic name given these spines was suggested by the transverse rows of coalesced tubercles with which the exposed portion is ornamented, and which are like miniature mountain chains. Usually the specimens of *Oracanthus* found in this country and Europe show a compressed, cornucopia-like cone, of which the base always, and the summit generally, is imperfect. The base, judging from these specimens, has been supposed to be the open mouth of a conical tube of which the large cavity was filled with cartilage; the edge of the opening being

bevelled and acute. Most dorsal spines of sharks found fossil have a conical, unornamented, solid base which was planted to a greater or less depth into the integument of the back, as a post is sunk in the ground; but the spines of *Oracanthus* show nothing of this solid base, and have the appearance of having been attached to the back as barnacles are fastened to the skin of the whale. This would seem to be a very inadequate support for these monstrous spines, and would make them only ornaments and not weapons. Hence their true structure and uses have been up to the present time a mystery. I have, however, recently received from Mr. W. F. E. Gurley, of Danville, Ill., a complete spine of *Oracanthus vetustus* Leidy, which fully solves the problem. Of this spine the exposed portion is a flattened cone seven inches high by five inches broad at the base; below this the buried portion is only about half an inch wide, but this is prolonged anteriorly into a transversely arched root or base about six inches long, making the entire antero-posterior breadth of the base more than ten inches. This shows that the spine was curved anteriorly and was supported by a strong root or base thrown out forward, which must have held it so firmly as to resist all blows or pressure from before. The surface of the exposed portion is covered with a sheet of enamel thickly set with conical, often stellate, tubercles. As it is much compressed and the anterior margin somewhat acute, the summit being curved forward, it forms a sickle-like organ, which, firmly rooted in the manner described, must have been a formidable weapon.

Such spines as that described above are quite symmetrical, and must have been placed on the median line of the back, but in the same beds with these are found short, broadly triangular spines which have the surface markings of *Oracanthus*, yet are so different that they have been with doubt referred to this genus. Several small spines of this peculiar character which occur in the Corniferous limestone of Ohio, I described in the *Bulletin of the National Institute* for 1857 under the names of *Oracanthus fragilis*, *O. granulatus*, *O. abbreviatus*, and *O. multiseriatus*. Later (1866) I described a similar spine from the Keokuk limestone in the second volume of the "Geological Survey of Illinois" (p. 117, pl. xii., fig. 3) with the name of *O. pnigeus*. In 1875 Mr. Orestes St. John took this latter spine as the type of a new genus, to which he gave the name of *Pnigeacanthus* ("Geological Survey of Illinois," Vol. VI., p. 480), giving to it the specific name of *P. deltoides*.

Facts which have recently come to my knowledge lead me to believe that all these last-mentioned short, broad, thin-shelled spines truly belong to the genus *Oracanthus* and were the de-

fences of the paired fins. Among the fish-remains sent to me for examination by Mr. Gurley, are several spines which have much the character of those described by Mr. St. John under the name of *Physonemus altonensis*, but which, as I have elsewhere shown, are certainly pectoral spines, since I have specimens in which the pectoral fin is still inserted in the posterior cleft. With these spines (which do not belong to the genus *Physonemus*, since they are not and never were tubercled) I have others, shorter, broader, and more robust, having the same anatomical characters and being, like the first, unsymmetrical, that is, having one of the edges which border the posterior cleft much broader than the other. These I have supposed to be the spines of the ventral fins. Also in the collection of Mr. Gurley is a short, broad spine with the surface markings of *Oracanthus*, and having, what is rarely found, the posterior margins entire. These are of unequal breadth, and, as in the pectoral spines of *Stethacanthus altonensis*, the posterior opening reaches nearly to the summit. I can come to no other conclusion than that this spine is the defence of either the pectoral or ventral fin of *Oracanthus*.

March 17, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About one hundred and fifty persons present.

The minutes of March 10th were read and approved.

MR. JOHN TATLOCK was nominated as Resident Member.

The sixth lecture of the Public Course was then delivered, entitled

NEBULÆ AND THE NEBULAR HYPOTHESIS.

BY PROF. CHARLES F. YOUNG, OF PRINCETON, N. J.

The lecture was fully illustrated by interesting lantern slides. At the conclusion of the lecture a vote of thanks was unanimously given to PROF. YOUNG for his entertaining and instructive lecture.

March 24, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

About thirty-five persons present.

The minutes of March 17th were read and approved.

MR. W. W. NEWELL was then introduced and read a paper on

THE STUDY OF FOLK-LORE.

(Abstract.)

The term folk-lore seems to many persons to cover a field of study not clearly defined. But this quality of indefiniteness is common to all terms used to denote studies connected with the intelligence of man. Anthropology, ethnology, psychology are each terms embracing a vague and infinitely extended field, which, in practice, is limited by more or less arbitrary boundaries.

By folk-lore is to be understood oral tradition,—information and belief handed down from generation to generation without the use of writing. There are reasons why the mass of knowledge,—including history, theology, and romance,—which has been orally preserved in any people, should be set aside as capable of independent treatment. Such matter must express the common opinion, or it would not be remembered; it must be on a level with the notions of the average rather than of the exceptional person; it must belong, that is, to the *folk* rather than to individuals.

The term folk-lore has its most definite significance in connection with civilized peoples of modern Europe, having been invented by an anonymous correspondent of the *Athenæum* (London), August 22d, 1846, who signed his name Ambrose Merton, understood to be a pseudonym for W. J. Thoms. He included under this title "Manners, customs, observances, superstitions, ballads, proverbs," and claimed the honor of introducing into the language the word "folk-lore," as Disraeli had claimed the honor of "fatherland." The latter word has not met with success, but "folk-lore" has been accepted not only in English speech, but also in most European languages.

It was soon evident that the oral traditions of Europe could not be treated by themselves without consideration of oral traditions in other parts of the globe. Customs and superstitions found in the United States, for example, not only among recent

immigrants, but also in families of the purest English stock, have evident connection with practices and beliefs widely extended among savage tribes. It was therefore necessary to extend the term folk-lore so as to cover these. There was some protest against these, inasmuch as the name *folk* belongs properly to races in which isolated tribes have been amalgamated into something resembling a nation. But this difficulty could not be allowed to prevent a convenient inclusion. So the expression came to be used, first, in a definite sense, as including tales, beliefs, and practices now retained among the unlettered peasantry of Europe; secondly, with a wider connotation, as embracing traditionary tales, customs, and usages of uncivilized races. In its broader meaning, therefore, folk-lore is a part of anthropology and ethnography, embracing the mental side of primitive life, with especial reference to the narratives in which beliefs and habits are related or accounted for.

The subject has two sides, the æsthetic or literary aspect, and the scientific aspect. Remarks were made on folk-lore from each of these points of view.

In treating of the literary side of folk-lore, the lecturer took his illustration from English ballads. The character of the ballad as a dance-song (late Latin *ballare*, to dance) was pointed out, and it was shown that dancing in couples, as a mere mode of motion, was comparatively modern. According to more ancient usage, a dance was a dramatic performance, setting forth a story, which was related in a song serving to guide the movement. An illustration of this custom was still to be seen in the "ring-games" of children. The date of collection of English ballads, and the periods of their composition, formed the theme of observations. It was shown that the circumstance of the late recording of many ancient ballads in Scotland, had led to the erroneous supposition that Scotland had possessed a distinctively national song, unlike that of England,—the fact being that so-called Scottish ballads were only dialectic survivals of songs formerly common to all parts of Great Britain. For the origin of these compositions it is necessary to look beyond the limits of the English speech, mediæval ballads not being the property of any one European country, but in a measure a common stock.

The qualities which rendered these songs of interest were remarked on, and popularity, simplicity, and antiquity were named as constituting the charm of the ballad. What has been repeated for centuries, has passed from lip to lip, and formed the joy of all classes, must stand on a different level from sentences penned for a chosen few. Ballads show that there was a period in which the mediæval noble and the mediæval serf stood nearly on the same intellectual level. These compositions serve as a perpetual

lesson of simplicity, and will always be of value to bring literature back to that character of naturalness and simplicity in which true art must consist.

Proceeding to treat of the scientific side of the study, an example of a surviving American superstition was cited in the practice still in use in certain parts of the country to charm rats away from houses by writing letters to them. A specimen of such a letter was read, for the accuracy of which the lecturer could vouch, the district being the sea-coast of Maine. It was shown that this method of ridding a house of rats was also occasionally used in Maryland. Comparisons from Scottish folk-lore showed that the superstition was spread throughout the English-speaking world. The custom was also shown to prevail widely in France, and its origin traced to the mediæval practice of addressing legal citations and ecclesiastical admonitions to animals.

Following out the subject into the belief of savage tribes, the underlying principle was shown to be a doctrine respecting the identity of animal and human existence. In uncivilized races, animals are supposed to be actuated by the same motives as men, and their communities to be organized according to the rules of ethics that prevail in human society. Examples of the relation of animals and mankind were taken from the religious medicine of the Cherokees. Finally, an account was given of the universal belief that animals can assume the human form, and appear at pleasure in that manner. In this manner it was made to appear that no account could be given of the American superstition without examining the character of primitive belief.

Finally, the great psychological importance of the collection of folk-lore, and the necessity of immediate effort to preserve a record of it in this country, were dwelt upon. As the secretary of the American Folk-Lore Society, the lecturer presented the claims of that body, and expressed a hope that steps would be taken to increase interest in the study in New York, and to obtain more general co-operation in the important task lying before collectors and special students.

President NEWBERRY remarked that the subject was one of great interest, and related some of his experiences with the Western tribes, now nearly or quite extinct; he also called attention to the loss sustained by the extinction of these tribes, their origin and migrations being depicted by tradition in the absence of written history. This, then, is one of the only means we have of gaining a knowledge of the aboriginal inhabitants.

PROF. MARTIN made some additional remarks on this subject,

and called the attention of the Academy to the important work of a former valued member, MRS. E. A. SMITH, in collecting the traditions of the Indian tribes of New York and Canada.

March 31, 1890.

BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

About one hundred and twenty-five persons present.

This meeting was held in the Chemical Lecture Room of the School of Mines.

The minutes of March 24th were read and approved.

The following recommendations of the COUNCIL were then read and duly approved, viz.:—

I. To appropriate $100 to pay the Assistant Recording Secretary, salary March, April, May, 1890, ... $100.00

II. Minor expenses, ... 40.12

III. To transfer A. FINK, Esq., to list of Corresponding Members.

IV. To donate to the University of Toronto all the duplicates now in the library, together with as complete a set of the Academy publications as possible.

The seventh lecture of the Public Course was then delivered, entitled

VOLTS AND AMPÈRES, AND WHAT THEY MEAN.

BY PROF. CHARLES F. CHANDLER, PH.D., OF COLUMBIA COLLEGE.

PROF. CHANDLER gave a brief and interesting history of electricity to the present day, explaining the various kinds of electricity, methods of producing them, and their application. The subject of electrical measurement was clearly and briefly shown by diagram. The lecture was illustrated throughout by

interesting and well-chosen experiments, slight deflections of the galvanometer being projected on the screen. The incandescent system of lighting used in the lecture-room was in operation during the lecture, and the lantern was illuminated by an arc light. DR. LAUDY and MR. PELLEW ably assisted PROF. CHANDLER in the experiments. At the close of nearly two hours a vote of thanks was unanimously given to PROF. CHANDLER by members of the Academy and their friends. After the lecture the working model of the Edison lighting system was on exhibition in the Chemical Museum.

April 7, 1890.

LECTURE EVENING.

The President, DR. NEWBERRY, in the chair.

Twenty-five persons present.

PROF. D. S. MARTIN read by title the following paper:

A REMARKABLE GROUP OF METEORITES FROM KIOWA COUNTY, KANSAS.

BY GEORGE F. KUNZ.

This paper will appear later in the TRANSACTIONS.

MR. BYRON B. GOLDSMITH was proposed as a Resident Member of the Academy by EDWARD GUDEMAN.

The PRESIDENT then introduced DR. MICHAEL I. PUPIN, who read a very interesting paper entitled

THE RELATION OF CERTAIN THERMO-DYNAMICAL PHENOMENA OF LIQUID SOLUTIONS TO THE ECONOMY OF NATURE.[1]

At the close of this very interesting paper there was some discussion by the PRESIDENT, DR. BRITTON, and others.

[1] On account of other pressing engagements, the author has been unable to furnish the editor with an abstract of this very interesting and important paper in time for publication in the current number of the TRANSACTIONS. The abstract of this article, with discussion, will appear in the May number.

April 14, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

One hundred and fifty persons present.

President NEWBERRY read by title the following paper:

ON CERTAIN CRINOIDEA OF THE LOWER NIAGARA LIMESTONE AT LOCKPORT, N. Y., WITH DESCRIPTIONS AND NEW SPECIES.[1]

BY DR. E. N. S. RINGUEBERG.

The eighth lecture of the Public Illustrated Course was delivered, entitled

METHODS OF RESEARCH IN BACTERIOLOGY.

BY GEORGE M. STERNBERG, MAJOR AND SURGEON U. S. A.

The lecturer began by giving a definition and a brief but interesting history of his subject, naming the more common diseases now known to be due to the growth and development of certain species of bacteria. In the course of his remarks he graphically explained how the bacteriologist proceeds in his difficult task of isolating and recognizing the various species, at the same time exhibiting to his audience the simpler forms of apparatus used in collecting and propagating these minute organisms. During the course of his remarks DR. STERNBERG paid eloquent tribute to the labors of Professors KOCH and PASTEUR. Toward the close of his lecture he exhibited many interesting lantern slides of pathogenic bacteria, many being taken from cultures which he had prepared with great care, and at the same time discussed the labors of other scientists who have been working in the same field. The slides were mainly from the bacillus of yellow fever; the lecturer was decidedly of the opinion that none of those proposed was the true source of this terrible disease. DR. STERNBERG is an eminent authority on this subject, and has given this particular question

[1] This paper will be published in the ANNALS OF THE NEW YORK ACADEMY OF SCIENCES, Vol. V., No. 7.

many years of close and careful study, during which time he has visited localities where the yellow fever seems to be indigenous, and has had exceptional opportunities of studying the course of the disease.

An unanimous vote of thanks was tendered DR. STERNBERG for his interesting and highly instructive lecture.

April 21, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Thirty persons present.

PROF. D. S. MARTIN read abstracts from an open letter received from the Pennsylvania Forestry Association, relative to petitioning Congress to pass the necessary legislative act withdrawing unoccupied Government Forest Lands from settlement. On motion, the PRESIDENT was empowered to appoint a committee of three to draw up and present, on behalf of the Academy, a suitable petition. The PRESIDENT appointed as such committee PROF. D. S. MARTIN, P. H. DUDLEY, Esq., and JUDGE ADDISON BROWN.

PROF. MARTIN invited the members of the Academy of Sciences to be present at a meeting of the New York State Forestry Association to be held at the American Museum of Natural History, Saturday, April 26th, 1890.

President NEWBERRY announced that the present meeting was given over to the Section of Mineralogy and the New York Mineralogical Club.

The first paper was read by JOSEPH H. HUNT, M.D., on

A GROUP OF COPPER PSEUDOMORPHS AFTER CHALCOCITE, AND SILICA AND PREHNITE PSEUDOMORPHS AFTER PECTOLITE, FROM PATERSON, N. J.

(Abstract.)

This group of specimens is from that interesting and picturesque region in New Jersey where the Passaic River breaks

through the hills, and, flowing over the basaltic cliffs, forms those beautiful falls so well known as the Passaic or Paterson Falls.

The quarry from which they were obtained is within the city of Paterson, and a few hundred yards north of the falls.

To me it has been a most interesting region, though I have had little time to study it, my visits having been hasty excursions taken with the Mineralogical Club last summer.

This quarry is in what would normally be the trap-rock, just over its junction with the red sandstone, on the north side of what I think is called Morris Hill, which is crowned with true columnar basalt, specimens of which I show you in three-, four-, and five-sided columns. The rock at the quarry is a breccia of trap, with copper minerals, mostly pseudomorphous in character, mingled with masses of porphyrite of a boulder-like shape, often several feet in diameter; the trap-rock itself is also much changed from that at the summit of the hill, approaching the porphyrite in appearance.

The original copper mineral has probably been chalcocite, the decomposition of which has possibly had much to do with changes which have evidently been produced in the mineral constituents of the quarry.

Not only is the copper broken down, but the trap-rock, which in other parts of the hill has the characteristic hardness, is also so softened and decomposed that it is readily quarried with the bar and pick, without much if any resort to blasting. This rotten rock is taken to the crusher near by and broken up, and used for road-making purposes in the city of Paterson.

Beneath this there is a layer of amygdaloid containing numerous nodular cavities filled with various minerals, such as prehnite, certain zeolites, etc.

In some places the amygdaloid is entirely decomposed, so that these little nodules of prehnite and pectolite can be gathered in quantities, free from the surrounding rock.

Beneath this is the red sandstone, baked hard and containing jasper-like masses showing the effect of heat where it is in contact with the overlying rock.

Here, it will be seen, we have one of nature's mysterious laboratories, of more than usual interest, opened at our very doors.

We have to do especially with the brecciated trap, which contains numerous cavities, from the size of the smaller vesicular nodules of the amygdaloid to several inches, or even a foot or more, in diameter. In fact, it resembles the amygdaloid on a larger scale, except that the cavities, instead of being close together, forming a sponge-like mass, are in some cases several feet apart.

These cavities, when minute, are filled, and when larger are lined, with beautiful chalcedony, quartz (crystals and pseudomorphic), prehnite (botryoidal and pseudomorphic), pectolite, datolite, heulandite, etc.

In some cases the effect is beautiful; frequently the immediate lining of the cavity (or outer shell of the geode) is chalcedony, upon which is the pseudomorphous quartz, which may be coated with quartz or amethyst crystals, and these may be sprinkled with crystals of stilbite or heulandite. Sometimes we find the pseudomorphous quartz covered with yellowish datolite.

The prehnite, as far as my observation goes, is always found alone, either in the ordinary botryoidal and reniform shapes, or, when pseudomorphous after pectolite, in the beautiful fan-like radiations which belong to the original mineral. I have observed it in but one part of the quarry, where the rock is more amygdaloidal in its character.

The great majority of the cavities have evidently been originally lined with pectolite, which has undergone alteration into either silica or prehnite.

The pectolite is found in every stage of pseudomorphism, from the silky, flexible crystals, in delicate radiating tufts, to the hard and rigid quartz, chalcedony, or prehnite, taking every imaginable form, from the fan-like radiations several inches across, to masses of quartz composed of what have been prisms of pectolite crossing each other in every conceivable direction. In some cases the pseudomorphism is by incrustation, when we find the masses filled with quadrilateral orifices running in various directions, looking like blocks into which cut nails have been driven and extracted,—in other words, like nail-holes.

Some of the solid masses, when the change is chalcedonic, make beautiful agates when polished. We also find agate in its natural concentric forms.

Some of the cavities are lined with quartz crystals with no evidence of pseudomorphism; but in most cases these quartz crystals are backed by a layer of massive quartz or chalcedony with pseudomorphous markings. Many of these crystals are amethystine in color; one amethyst geode I have, with crystals containing phantoms.

In many cases the crystals are thickly sprinkled with microscopic crystals of what I think is cuprite, embedded in the surface of the crystals, and sometimes even in their interior, forming beautiful inclusions.

In most cases the quartz pseudomorphs are milky-white, but some of the specimens I have are stained red, probably with cuprite; and one specimen is stained a bright malachite green.

Most of the red crystals are exceedingly fine radiations spread

out in a thin layer upon the more than usually hard basalt, having been formed in seams instead of cavities.

Some crystals of calcite in the form of dog-tooth and rhombohedral spar are found, but most of them are imperfect. Casts of calcite crystals, forming pseudomorphs by incrustation, are not uncommon.

Heulandite occurs in coffin-shaped crystals, some of them quite large; I have one over an inch in length.

Datolite is found in fine, straw-colored crystals, and massive, and in my specimens all deposited on the pseudomorphous quartz.

Stilbite is obtained in radiating tufts, and deposited upon the *crystals* of quartz.

Chabazite and analcite, in rose-colored crystals, are also found; and some of the cavities of the amygdaloid contain natrolite.

Of the copper minerals we have chalcocite and chalcopyrite, and probably pseudomorphous after these,—malachite, azurite, cuprite, and chrysocolla.

To recapitulate;—You have before you one hundred specimens illustrating the product of this quarry.

First the solid columnar basalt from the summit of the hill; basalt from the side of the hill next the falls, showing on one side the action of the atmosphere and spray in decomposing the surface, producing an effect not unlike that shown in the spongy amygdaloid when the cells are empty, but differing from it in that it is confined to the surface of the rock.

You have the trap-rock from the quarry, brecciated with the various copper minerals, which are seen to be still decomposing, some of them crumbling since they have been in my possession.

The hard, jaspery porphyrite; the amygdaloid, a spongy mass of cavities, some of which are filled, and others from near the surface, where they have been exposed to the elements, empty, resembling spongy scoriæ.

The normal pectolite in silky fibres and numerous stages of the change to silica or prehnite.

The normal prehnite in reniform and botryoidal masses. One specimen shown, from the D., L. & W. R. R. cut on the other side of the river, half a mile away (collected several years ago), differs from that found in this quarry only in being lighter colored; we see, too, the fan-like pectolite forms in beautiful radiations of green prehnite.

The normal calcite crystals, which are neither abundant nor fine; but silica pseudomorphs by incrustation after calcite, the included mineral having been dissolved away, are plentiful, showing that the more soluble mineral was once quite abundant.

We have datolite, heulandite, stilbite, chabazite, and analcite, —in each case deposited on the surface of the quartz, and quartz crystals deposited upon pseudomorphous quartz, showing that they have all been secondary deposits.

The cuprite is often in minute crystals and radiating rosettes; the chalcopyrite is also in small crystalline masses.

The chalcedony pseudomorphs after pectolite in some cases form beautiful tabular plates; in other places the radiations of the pseudomorphous chalcedony may be followed through the changes to the concentric markings of fortification agate, with no resemblance to pectolite. We find some of the cavities lined with a thick, chalky cream, soft when first opened, but becoming hard upon exposure. It has the nodular appearance of hyalite or chalcedony, but milky-white in color and not translucent. This I have labelled nascent chalcedony. In other cases we find the process seemingly farther advanced, stage by stage, to the semi-transparent chalcedony, often in beautiful microscopic nodular or stalactitic shapes.

This quarry is interesting, not only to me, the unscientific collector of the beautiful and curious in nature, but also to those who are true scientists, engaged in investigating the secrets of nature's works.

It seems to me that here we have exhibited the workings of a chemical and physical laboratory on a grand scale. Not only the effect of the great heat of nature's furnace, when this basalt was thrust through the crust, as shown by the baked red sandstone on the exposed surface which was in contact with it, but by the vesicular, lava-like amygdaloid, and by the larger cavities in the basalt lined with crystals of zeolites and other minerals.

We have also shown the results of more direct chemical action, beginning with the decomposing effect of the atmosphere and water, which probably first attacked the sulphides of copper; then having the aid of sulphurous acid, in addition to the carbonic acid with which it was already charged; the alkalies, lime, and sodium from the decomposition of calcite and pectolite; and other chemical agencies which suggest themselves.

It is but fair to say that no chemical analysis of these minerals has been made. I have named them entirely upon my own responsibility, guided by their general appearances and some of their physical properties.

President NEWBERRY made some very interesting statements in regard to the formation of cavities in the soft rock by gases, and the subsequent deposit of minerals in these cavities by hot solutions.

The second paper was read by MR. GEORGE F. KUNZ, on

THE MINERALS EXHIBITED AT THE PARIS EXPOSITION OF 1889.

(Abstract.)

Fifty-five nations were represented at the Paris Exposition, and nearly every one of these had a governmental exhibit of the minerals of its country, besides in many cases combined exhibits of private collectors. Some of these displays were very remarkable, and had they been assembled in one building, as was the machinery in Machinery Hall, the mineralogical and metallurgical and precious stones exhibits would have been more impressive. As it was, they were scattered over such immense distances that important ones were often overlooked.

Class 41, which included minerals, or, in other words, the products of mining and the materials obtained therefrom, contained over 1,800 distinct exhibits. In the French Section, a collection of gold shown in this class by M. Bouglise, a French engineer, was perhaps the finest ever formed. It contained many remarkable specimens of gold from California; a wire of gold, six inches long, from Colorado; gold amalgam, nuggets, and gold-dust. The three hundred specimens represented almost every gold-producing country in the world, and the collection was the result of over thirty years' work.

In the Liberal Arts Section were remarkable exhibits of artificial minerals, exposed by M. Friedel, of the École des Mines; and a collection by MM. Bourgeois and Gorgeu, formed from heated solutions in glass tubes, among which were artificial feldspar and other minerals never obtained by direct heating in a crucible.

Dr. Fouque and Michel-Levy exhibited a magnificent series of rock-sections, as well as the colored plates illustrating their works on petrography. Dr. Fouque also displayed specimens of the famous artificial, as well as the antique, Egyptian or Pompeian blue, from the ancient frescoes of Pompeii, which for a long time had been a puzzle to scientists, but which Dr. Fouque demonstrated by analysis to be wollastonite; and the artificial product made by himself was fully equal to the original in beauty of color.

M. Etard exhibited beautiful groups of artificial argentite crystals.

In Class 15, instruments of precision were shown by M. J. Werlein. Here were to be seen microscopically prepared sections of orbicular diorite from Corsica, violane from the Pyrenees, granite and other rocks, measuring four inches square and as thin as any microscopic section could be prepared; also some beautiful

optical preparations of crystals of quartz, plates four inches long and about one-one-hundredth of a millimetre in thickness, which had been cut parallel to the rhombohedral face. These, when punctured with a needle or sharp point, would always separate into perfect rhombohedrons, showing that quartz, when properly prepared, has as perfect a cleavage as any species. Mineralogical and petrographical microscopes were shown by MM. Nachet and Bertrand; goniometers by Fuess; the goniometers of Mallard and Wyrouboff, manufactured by Lutz; and the Dufet apparatus for measuring the angle of optical axes, manufactured by Ducretet.

In the centre of the French Jewelry Section, Class 37, was exhibited the Imperial or Victoria diamond already described; at one of the four central corners, by Bapst & Falize, the historic Sancy diamond, weighing forty-one carats; opposite, a necklace composed of pink, blue, yellow, brown, black, and other colored diamonds. This section contained an immense number of fine and curious diamonds, rubies, emeralds, and other precious stones, as well as several interesting lapidary exhibits, and nearly fifty exhibits of imitation stones of all kinds, imitation pearls, etc. A carved diamond turtle and fly, and some curiously drilled diamonds, were of more than ordinary interest.

At the Exposition there were three exhibits at which the branches of cutting and polishing were carried on. At the Holland pavilion the display made by Boas, of Amsterdam, had a number of polishing wheels, the motive power of which was steam, as well as a machine reconstructed, showing the manner in which man-power was utilized during the eighteenth century. With this exhibit there was a large series illustrating the various forms of cutting the brilliant, rose, and table, as well as all the forms of rough diamonds, such as cleavages, splints, those for glass-cutting, and shaped for specially adapted tools.

Two Belgians exhibited diamonds,—one, M. Latinie, a perfect yellow octahedral diamond, weighing three hundred carats; a diamond cross cut from a single stone (which is not unique, as claimed by the exhibitor, for such a stone was contained in the Hope Collection, and was illustrated in the Hope Catalogue of 1839); some fanciful and curiously cut brilliants; a small sword cut out of three diamonds; and the name of the exhibitor in table diamonds, seventeen of which were nearly an inch in length.

In the main aisle Coutermans, of Antwerp, had an exhibit with the polishing wheels, a series of the diamonds in the altered kimberlite, and a black diamond, weighing thirty carats, which it was reported had been purchased by the Shah, but of which in reality he only inquired the price.

The most important exhibit was in the United Diamond Mines Building,—in other words, the De Beers Mine, Limited, which company controls twenty-nine-thirtieths of all diamonds mined to-day—in which every process connected with the mining and cutting of the diamond could be seen under one roof.

First, the large sacks of earth, of which one thousand were washed at the Exposition, were thrown on a screen which sifted the material into a large washing-pan, or "compound," as it is called, about fifteen feet in diameter. In this compound all the soft mud, light particles of shale, kimberlite, quartz, calcite, and other minerals whose specific gravity is less than that of the diamond, were floated out, and in the centre the diamond, garnet, pyroxene, and heavier minerals were concentrated. These concentrates were then carefully sorted, the garnets and the diamonds being the only ones of value.

In connection with this exhibit were shown models, or rather reproductions, made of earth, and small models, exact duplicates of the machinery and the tunnel systems used at the South African Mines. In a large iron "parrot-cage," similar to the one in which the Kohinoor diamond was exhibited at the London Exposition of 1851, the De Beers Consolidated Mines exhibited 5,138 carats of rough diamonds. Among these was a cut diamond, the largest brilliant in the world, weighing 228½ carats, which in the rough weighed over 400 carats, and one large octahedral crystal weighing 306 carats, and a collection of 983 carats of fancy-colored crystals of white, mauve, pink, orange, yellow, brown, and black; also a large number of distorted and curious crystals. The Bulfontein Mine exhibited 11,227 carats of rough diamonds, and the Griqualand West Diamond Mining Company a parcel of 45,003 carats.

At the opening of the Exposition the diamonds were valued at 22 shillings a carat, and at its close at 38, so great has been the advance in the price of rough diamonds. One thousand sacks of diamond-earth were washed at the Exposition, and the average amount of diamond found was 1½ carat to a load of earth.

In connection with this exhibit was the cutting of diamonds, carried on by M. Roulina, who reintroduced diamond-cutting in France, and is one of the few men abroad who has utilized a machine for the process. This machine, however, is very primitive in comparison with the more perfect one invented fifteen years ago in the United States and in use here since. There were also diamond-piercing machines in operation; these required from twenty to thirty days, of six hours each, to pierce a diamond of about two millimetres in thickness, the piercing point making 15,000 revolutions per minute.

Not without interest were the fragments of a diamond which

had once been a beautiful white stone of about nine carats, but which shattered into fragments while undergoing the polishing process on the wheel.

Greece made a magnificent display from the famous mines at Laurium, which were worked before the beginning of the Christian era. This is proved beyond doubt by the fact that, in the collection in the Assyrian Gallery in the Louvre, the writer saw necklaces made of beads of gold and carnelian, and also, to his surprise, of the blue and white veined beads of calamine from Laurium. Masses of this mineral were displayed that must have weighed at least a ton each, and in the general exhibit were magnificent botryoidal specimens, from this locality, of the blue, green, and yellow calamine, which rivalled anything found elsewhere.

In the Persian Section were shown masses of lapis-lazuli weighing several pounds each, and a large series of cut and engraved Persian turquoises.

In Class 18, Section of Decorative Arts, were some fine chandeliers of rock-crystal, valued at $7,000 each; pedestals covered with slabs of agate amethyst from Lorraine, valued at over $2,000 a pair; rock-crystal spheres (not perfect, however) up to 6½ inches in diameter; and other magnificent examples of lapidarian work in agate, jasper, rhodonite, and jade.

From the Pyrenees and from Belgium, magnificent collections of finely colored marbles were shown.

Spain exhibited a large collection of apatite, transparent yellowish-green crystals, of the variety known as "asparagus stone," one inch in length, from the mines of Jumilia.

Servia sent a large exhibit of the ores of mercury, among which were beautiful crystallized cinnabars, as well as the white crystals of chloride of mercury (calomel) from Mt. Avala.

There was a series of interesting specimens, illustrating the occurrence of ozokerite, from the famous mines of Boryslaw, Galicia, which are still in active operation, notwithstanding the threatened competition of this same material from Utah.

The Russian exhibit contained a case of nephrite and graphite, displayed by M. Alibert, similar to the collections shown at the Expositions of 1867 and 1878, which were presented by M. Alibert to the Ecole des Mines, the Musée Naturel, and the Conservatoire des Arts et Métiers. Jade was formerly obtained by M. Alibert in his graphite mines in Siberia, discovered in 1847 at Botogal, in the Sian Mountains, near the Chinese frontier. One mass of jade from these mines weighs 1,300 pounds, another 1,100, and several of the specimens in the case weighed several hundred pounds each.

Of even more interest were the polished, transparent sections

of boulders of jade sawn by M. Alibert from blocks found by himself; these were beautifully polished on both sides, were less than one-eighth inch in thickness, and some measured three feet in length and over eighteen inches in width, forming beautiful panes for windows, having a delicate shading and a brilliancy not to be obtained in any other material. With this was a large series of graphite, curiously carved into ornaments, to show the perfect homogeneity and fine grain of the graphite from his mines.

The collection of Mr. Woerfel contained a large number of the table-tops, mantels, vases, and other ornaments of malachite, lapis-lazuli, rhodonite, Labrador spar, and other stones characteristically Russian, which have been used extensively in that country in the decoration of churches and palaces, and have been frequently made use of as imperial gifts by the Czar, as the royal palaces throughout Europe will testify.

From the Ural Mountains came an exhibit of a magnificent series of blue, white, and sherry-colored topaz crystals, some of the largest of which weighed one pound, and some smaller ones, several inches in length, were absolutely transparent; a doubly terminated crystal of beryl that weighed one pound eight ounces, but was not entirely free from internal fractures; small crystals of alexandrite; some magnificent purple amethysts, unrivalled for depth and richness of color; a chrome tourmaline in crystals from one to three inches in length, and other varieties of well-known Russian minerals.

Paul de Kristoffowitch exhibited a very interesting material, termed by him pyrogranit, for which he has secured patent rights in many countries. It is obtained by vitrifying slates and shales, and it imitates closely many varieties of marble, porphyry, and granite, having almost the hardness of the latter, and being susceptible of a high polish. It was shown as bath-tubs, tiles, and ornamental pieces, and is undoubtedly the most satisfactory of the artificial stones that have been produced.

The Russian Society for the Mining of Mercury, formed by Dr. Auerbach, the chemist, made a splendid exhibit of the ores and of native mercury from their mine. This mine was discovered by M. Minenkoff in 1879, but no development was attempted until 1886. The mine and the works are in Central Russia, in the jurisdiction of Ekatherinoslaw, Bakmouth District, four kilometres east of the station Nikitowa on the Koursk-Karkoff-Azof Railroad. Besides the surface of cinnabar, covered with brilliant crystals, of special interest to the mineralogist were the quantities of perfectly detached crystals and penetration rhombohedral twins of cinnabar, which are quite unique; they measure from two to three millimetres across a face.

A notable feature in the Norwegian Section was the exhibit of the famous Kongsberg silver-mine, in which were displayed ropes and wires of silver, some over twelve inches long, varying in thickness from that of a needle to more than an inch; these were interlaced, and in part attached to the rock. Even more striking, however, was a perfect cube of native silver fully an inch in diameter, and some groups of cubo-octahedrons, measuring over half an inch in diameter, and covering surfaces over four inches square. Plans and diagrams of the mines accompanied this series.

Of considerable interest was a commercial exhibit of the minerals containing the rare earths, which in Norway are carefully preserved by the miners of feldspar, apatite, and quartz. The exhibit contained orangite, gadolinite, fergusonite, zircon, molybdenite, and other minerals, to be sold by the pound. In one collection were fine crystals of thorite, broggerite, zircon, gadolinite, molybdenite, etc.

The Hungarian Section contained a very interesting case of opals, and also opal in the trachyte matrix, from the famous Hungarian mines at Czernowitza, which have been worked for over three hundred years.

In the Roumanian Section was exhibited a remarkable series of ambers, strikingly like those from Catania, Sicily, in form and in color; the different colors shown were light yellow, dark yellow, cloudy-white, opaque white, black, brown, bluish-green, dark opalescent blue, opaque red. This amber was all found in the department of Buzeo and in these places: Bisca-rusilei, Bisca-Chisjdului, Coltzia, Valea-boului, and Bodila. The Roumanian amber is exceedingly rare, and is very highly valued in that country.

The United States exhibit of minerals was prepared by Prof. William P. Blake, and was under my charge at the Exposition. It was not intended to be a complete collection of American minerals, but rather such a representative series as could be gathered in the short time allotted to its formation. Among the exhibits may be mentioned that of the famous Anaconda Mining Company, containing a set of specimens forming a series of the ores, concentrates, and matte of that great copper-mine. Prof. Blake exhibited a crystal of columbite, of the size of a man's hand, from the Black Hills; the Copper Basin Mining Company had a fine series of malachite and azurite in the sandstone conglomerate, from Copper Basin, Prescott, Yavapai County, Arizona; from Harney Peak, Black Hills, Dakota, were several tons of vein rock, illustrating the occurrence of cassiterite; from the New Almaden quicksilver-mines, California, a case of fine specimens of cinnabar and bitumen associated with native mer-

cury. Besides these there were seventy-five minor exhibits. In this section also was the collection of minerals, partly American, exhibited by Prof. A. E. Foote, and a large display of agatized trunks and sections of trees, with polished sides, of the jasperized and agatized wood of Arizona, to which was awarded a gold medal.

A collection of precious and ornamental stones of North America, as well as a collection of foreign precious stones, was displayed by Messrs. Tiffany & Co. in the American Section. The former collection was contained in a circular case nine feet in diameter, on a platform erected at the intersection of the four aisles of the American division. This collection was formed for the purpose of illustrating the occurrences of the precious and ornamental stones in North America, and contained many of the finest examples that have been found, some unique, others entirely new. This collection was the result of purchase, completed by generous loans from some of our prominent mineralogists, and was an object of interest to the many visitors to the Exposition.

One of the features of the jewelry exhibit was the utilization of American stones and pearls in jewelry, notably tourmalines, beryls (yellow, green, and blue), rock-crystals for vials and boxes, and pearls from the Unios in a large variety of objects;—the motive as well as the materials employed being American in character.

Among the more important things in this collection were some small diamonds from California; a series of the original crystals of sapphire collected by Col. C. W. Jenks when he opened the Jenks Mine in Franklin, Macon County, North Carolina,—among them the first sapphire found in the United States; a ruby of fair color, some American crystals and cut topazes, from Cheyenne Mountain, Colorado; one of the largest crystals of emerald from Alexander County, North Carolina, loaned by Mr. Bement; the cut aquamarine, weighing $133\frac{5}{32}$ carats, from Stoneham, Maine; thirteen cut aquamarines from Mt. Antero, Colorado, found at an altitude of 14,000 feet above the sea; a number of cut spessartite garnets, one of which weighed $96\frac{1}{16}$ carats, from Amelia Court-House, Virginia; a series of colored tourmalines, both cut and in crystals, from Mt. Mica, and from Auburn, Maine; a collection of pearls, and the shells in which they are found on the shores and in the rivers and brooks of North America.

Some notable things in the Tiffany foreign collection were a series of twenty-four fancy-colored sapphires, weighing from two to twenty carats, and showing every color of the spectrum; some fine alexandrites, chrysoberyls, and zircons from Ceylon;

crystals and cut euclase from Brazil and Siberia; and a number of interesting precious and ornamental stones.

The Mexican exhibit was especially rich in its display of silver ores. Magnificent masses were covered with wire silver, and some lumps of amalgam weighed twenty pounds each. There were shown here splendid crystals of argentite, stephanite, pyrargyrite, also scalenohedral crystals of calcite, of the Iceland spar variety, over six inches long and four inches in diameter, covered with beautiful white crystals of stilbite, similar to that from Iceland. Magnificent veined blocks of the so-called Mexican onyx came from Tecali, in the State of Puebla, and a large series of casts of Mexican meteorites, of many of which little is known outside of Mexico. These casts were presented to the Imperial Museum at Vienna.

In the magnificent building of the Argentine Republic, the National Department of Mines, of Buenos Ayres, Director-General H. D. Hoskold, had a collection of eighty flat cases 25x35 inches. Among the more important exhibits were the large series of silver minerals from the Cerro Negro Mountains in the province of Rioja, consisting almost entirely of native silver in limestone, frequently associated with zinc-blende. The silver was either in wires, cubes, or veins, with cerargyrite and argentite. A mineral was also exhibited under the name of argentarsenickel, claimed to be a new species, with the following analysis:

Silver	32.22
Zinc	6.60
Nickel	12.58
Iron	8.40
Manganese	0.70
Arsenic	23.46
Sulphur	13.04
Insoluble matter	2.60
Moisture	0.34
	99.94

The ore of this district is exceedingly rich, and an assay gives 8,771 ounces of silver to the English ton. Among some specimens were also proustite and stephanite; a large series of specimens, exhibiting free silver and gold, from the province of Catamarca; from the province of Salta, a large series of copper minerals containing ores of silver, lead, and antimony, notably some beautiful crystals of stephanite. From the province of Cordoba were some interesting marbles, one a beautiful concretion of rose-colored marble about eight inches in diameter; from the province of Salta large crystals of borax; and a case was filled by

the Sociedad Minera, Republicana Argentina, from the mines of Candecara, showing magnificent specimens of auriferous quartz containing cavities filled with free gold.

The Brazilian Commission exhibited a very interesting collection of the precious stones of Brazil, especially the diamond and its associations, but not such fine examples as those shown at our Centennial Exposition. Many of the choice specimens in this exhibit were loaned by European collectors and dealers. Among those of chief interest were a dish of yellow topaz crystals, several of them over two inches in length and one inch in diameter; magnificent crystals of green tourmaline from two-and-a-half to four inches long; fragments of crystals of amethyst two and three inches in diameter; diamond crystals from less than the size of a pin-head up to six carats. There was also a collection of minerals associated with the diamond in Brazil, consisting of rutile, zircon, anatase, lazulite, and a set in miniature of the implements and bowls used in washing and in digging and working the river gravels. This entire case was the production of the province of Minas. Of special interest were the "Sables Diamantiferes," as the conglomerate rock containing the diamond is called, and also the masses of klaprothine, identical with the lazulite of Georgia, and the series of minerals of the gravels which were identified by Prof. Gorceix, of the School of Mines at Oura Preta, among which were pyrope, cyanite, pyrite, fibrolite, xenotime, anatase, hematite, limonite, tourmaline, monazite, baierite (titanic iron), and itacolumite rock. These are especially interesting since they have all been found in North Carolina and Georgia. The Viscountess de Cavalacantie exhibited a case of jewels from the province of Minas, among which were some fine amethysts, topazes, aquamarines, citrines, and five beautiful examples of the chrysoberyl or chrysolite jewelry worn and made in the latter part of the eighteenth century.

Among a remarkable series of ornaments made and worn by the Botocudo Indians of Brazil were some made of materials of marked mineralogical interest. The most notable were lip-ornaments, one a rich Amazon-green feldspar in the form of a disc, two-and-a-half inches in diameter and about one inch thick, with projecting shoulders for retaining the ornament in the lip. The great breadth of this would suggest difficulty in the use of a pipe, but Dr. Ladislaus Natto, Director of the National Museum, Rio de Janeiro, exhibited a pipe used by the Indians, adapted to overcome this difficulty. The stem was flat and over two inches in diameter and quite thin, so that it could be laid on the projecting lip-ornament and easily held in the mouth. Another lip-ornament was three inches long and an inch-and-a-half wide; another an oval disc three-and-a-half inches long and one inch

thick, of beryl; a flat, sole-like fish, two inches long and one inch wide, made of a material said to be jade; a circular shaft of rock-crystal, five inches long, with two projecting ends; two spear-heads, three and four inches long, and some ear-ornaments, all made of transparent rock-crystal.

Undoubtedly the richest mineral exhibit at the Exposition was that in the Bolivian Pavilion. The famous Huanchaca Company reproduced a gallery of the Pulacayo mine. This gallery, which served as a rear entrance to the building, was twenty feet long and seven-and-a-half feet high, and contained 60,000 pounds of ore, valued at 170,000 francs. Bars and ingots of silver, valued at over 300,000 francs, were exhibited by the company.

From the mines of Corocoro a magnificent display of crystallized native copper, in the form of radiating, arborescent sheets.

A remarkable exhibit of native bismuth was made by the Aramayo Company, from Tupiza Sanyree y Muerte a Tasna, containing some of the most magnificent specimens of native bismuth probably ever seen; one of these was a brilliant cleavage-mass, covered with crystals more than two inches across, and weighing at least four kilos. There were also magnificent masses of carbonate of bismuth—valentinite—in orthorhombic prisms three inches long.

In the Bolivian Pavilion was also a series of specimens of lapis-lazuli from the Andes, to which were given four distinct names,—*i.e.*, lapis-agatado, lapis-lazuli, lapis-maclado, lapis-laminosa. Peculiarly interesting, also, were the large masses of talcose slate, filled with hexagonal crystals of aragonite and hexagonal pseudomorphs of native copper, replacing aragonite.

The Colquechaca Company exhibited a specimen of botryoidal arsenic covered with crystals of proustite, measuring 25x20 inches and weighing three hundred and twenty pounds; also a quantity of smaller specimens with the proustite in fine crystals.

The Company Itos had a large exhibit of silver minerals and fine specimens of proustite. Portions of wall-rock a foot square were covered with beautiful acicular crystals of jamesonite, matted like mineral wool, and an inch thick. These were as fine as anything ever found.

An interesting series of silver minerals was exhibited by the famous silver-mines of Potosi, which are situated at an altitude of 14,000 feet above the level of the sea. History tells us that the Spaniards obtained from these mines, about the beginning of the sixteenth century, $2,000,000,000 worth of silver by the sacrifice of the lives of millions of natives, who, when once set at work in the mines, rarely returned to their homes.

The Chilian Court contained a collection of four hundred

specimens, a very complete metallurgical rather than mineralogical exhibit of the gold, silver, copper, zinc, and lead from Chili. Among the few specimens of mineralogical interest were two beautiful groups of proustite (ruby-silver) from Caracoles, and a fine display of nitrate of soda from Tarapaca.

The Paraguayan Republic showed little else than some handsome marbles and specimens of rock and refined salt.

Among the forty-four exhibits from Salvador may be mentioned native platinum, iron pyrites, jasper, and porphyry.

In the New Zealand Court were two large polished blocks of green oceanic jade, weighing two hundred pounds each, and magnificent specimens of scheelite.

In the South African Pavilion were exhibited from the new gold-fields of South Africa, in a large safe, native gold valued at over $60,000.

In the Esplanade des Invalides, in the Palace Algérien, was an interesting collection of minerals from the province of Constantine, consisting of beautiful marbles, Algerian alabaster (an aragonite), concretions of phosphorite and calamine, and groups of senarmontite crystals.

The Madagascar Pavilion contained a series of gravels containing sapphire, zircon, and tourmaline.

In the Japanese Exhibit were beautiful crystals of colorless topaz.

A large and interesting collection of nickel ores, noumæite, garnierite, etc., came from New Caledonia, similar to those from our nickel-mines at Riddle, Douglass Co., Oregon.

To the numerous allusions that have been made in the press to the exhibit of artificial precious stones at the Paris Exposition, is probably due the popular error that confounds the word "artificial" with the word "imitation." Not a single artificial diamond, ruby, or sapphire was shown, but there were some hundred of exhibits of imitation stones from France, Austria, Hungary, and Germany. The term "artificial" can be correctly applied only to a gem that is artificially made, whereas the term "imitation" covers all glass and such other productions.

After the reading of the above-mentioned papers, Dr. Hunt exhibited a large series of specimens of great interest, illustrating his paper on minerals from Paterson, N. J. Mr. Kunz exhibited specimens of the Kiowa County meteorite, native antimony from California, a so-called amber from Mexico, and calcite cleavages from Lampasas County, Texas, which, on placing close to the eye and looking through them at a fixed point

of light, showed distinct asteriation,—two, three, or four bands of light crossing each other and forming a four-, six-, or eight-rayed star,—and frequently a spark of light was to be seen from the point of each ray. PROF. MARTIN exhibited a case of minerals and rocks of New York and vicinity, forty-nine specimens, collected and presented to the New York Lyceum by MR. ISSACHAR COZZENS, half a century ago.

April 28, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Two hundred persons present.

E. G. DUNN, Signal Officer U. S. A., was proposed as a Resident Member of the Academy by W. E. ELSEFFER, C.E.

The ninth and concluding lecture of the Public Illustrated Course was delivered, entitled

GLIMPSES OF ARCTIC SCENERY.

BY WILLIAM BRADFORD.

The lecturer described scenes and places on the coast of Greenland and adjacent shores visited by him during a voyage on the steamer *Panther*. A vivid description was given of the majestic grandeur of these icy regions. The inhabitants of Greenland, their customs, habits, dress, and character, were treated of in detail, with stirring accounts of a hunt for polar bears and the results of the chase, encounters with huge icebergs, and the terrors and dangers of navigation in the pack-ice. During the course of the lecture a large number of beautiful and interesting lantern-slides were exhibited.

At the close of the lecture a vote of thanks was unanimously tendered to MR. BRADFORD. President NEWBERRY announced to the audience that this was the closing lecture of the Public Course, and stated that he hoped during the coming year the Academy would have a course as well arranged and chosen. A resolution of thanks to the Committee on the Public Lecture Course was then proposed and passed.

May 5, 1890.

REGULAR BUSINESS MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-five persons present.

The following recommendations of the COUNCIL were approved:—

I. The election as Resident Members of

EDWARD K. DUNHAM.
JOHN TATLOCK.
E. B. DUNN.
BYRON B. GOLDSMITH.

II. The payment of the following bills:

Publication of ANNALS, Vol. V., Nos. 4, 5, 6, and Index to Vol. IV.	$359.20
Printing Notices of Meetings	28.35
Minor Bills	32.45
Stationery	20.50

The paper announced for the evening was then read, upon

TERMITES OF THE ISTHMUS OF PANAMA.—PART II.

BY P. H. DUDLEY.

(Abstract.)

In the previous paper on the "Termites, or so-called White Ants, from the Isthmus of Panama," I stated that three genera had been identified by Dr. Hagen, viz., Termes, Eutermes, and Calotermes, the latter being represented by only one species. Since then several more have been found. The species of this genus on the Isthmus have not given any evidence of building exterior galleries, do not break the surface of the wood they are in, and are therefore difficult to find until extensive damage has been done to the woodwork. The principal evidence of their presence is a few partially digested pellets of wood, one-fiftieth of an inch long by one-one-hundredth in diameter, which may be found upon the floor of cars or furniture they are attacking.

Further study of the habits of the different genera of the

termites upon the Isthmus shows that measures which may be effectual against one genus may not be so against another, and in order to carry out practical measures to check their destructiveness it is necessary to designate each genus so that ordinary workmen can distinguish them. In my paper of last year I stated that Eutermes was made a subgenus of Termes by Heer, owing to the peculiar venation of their wings. This means of classification included in the same genus species having soldiers with mandibles and species having soldiers with beaks, of different habits. On the Isthmus the venation of the wings is not constant, nor can winged insects be found at all times of the year. In my first paper I proposed to call all the species having soldiers with beaks Eutermes. This did not avoid the confusion, and I now call them Nasutitermes—soldier-nosed Termes.

The Genus Termes.—The workmen know, when they break a gallery and find a number of mandibulate soldiers, the nest is likely to be near and inside some post or beam, unless it should be the species *Termes columnaris,* Beaumont, in which case it will be an earth-nest.

The Genus Nasutitermes.—When they break a gallery and find soldiers with a beak, the nest may be a long distance away, 50 to 200 feet, and will be outside of the timbers, and the workmen know they are Nasutitermes.

Calotermes.—If the workmen do not find exterior galleries, but a few little pellets of wood on the floor, they know the Calotermes are in the wood.

For each genus the treatment must be different, and these simple designations for classification can be readily understood by those who must deal with the subject practically. In the former paper many of the intelligent habits of the termites, especially of the genus Nasutitermes, were described and illustrated. Wonderful as they were, continued observations show many more far surpassing in interest those first described.

The large numbers of queens found in a single nest,—from two to fifty-five in the Nasutitermes,—is astonishing. In the genus Termes not only have a number of queens been found, but the surprising fact of another series of auxiliary queens as well.

In studying the observations of Mr. Charles Lespes upon *Termes lucifugus* in 1854 at Bordeaux, he designated large and small kings and queens. Dr. Fritz Müller, at Itahy, Brazil, in 1872, confirmed Lespes' statement. These statements I communicated to Mr. Beaumont, and had him search for the auxiliary queens, and after opening many nests he found among the species of *Termes columnaris,* Beaumont, and *Termes minimus,* Beaumont, the two distinct forms of kings and queens.

The marked distinction between the two is that the true kings and queens develop from winged imagos, which swarm, and after a short flight alight on trees, buildings, or the ground, lose their wings, and cannot return to the parent-nest by flight. They pair and seek a hiding place.

The auxiliary kings and queens come from nymphæ with aborted wing cases, and are apterous and cannot leave the parent-nest by flight.

This is an astonishing provision of Nature. First, a swarm of winged males and females to disseminate the species. Second, a supply of apterous males and females to keep up the parent-nest in case the first class should all swarm.

It is stated that the auxiliary queens are found with all the genera mentioned, but to date only those of the genus Termes have been discovered on the Isthmus. The observations made by Mr. Beaumont since the date of the last paper to July 4th, 1889, have been compiled by Mrs. Dudley into the following paper:—

COLON, S. A., August 4th, 1888.

MY DEAR MR. DUDLEY:—Many of our best residences on the beach are haunted (anted) by the destructive Nasutitermes, and we have not discovered anything yet by which we can effectively spirit away the silent intruder. Have you found with your microscope any special organs for secreting the cement so useful to the workers? A suspicion is dawning upon my mind that this cement may be the natural excretion from the alimentary organs, so extensively and economically used to construct their nests and galleries. I am surprised that this peculiarity of the Nasutitermes (Eutermes) has not been observed and commented upon by naturalists before, as it is one of the wonderful facts about them. They are enormous feeders, and must have well-developed digestive organs to keep up the supply of such profuse secretions.

I am pleased to learn that Dr. Hagen values my observations, and that the name of the ant which destroyed my office window-frame is *Termes testaceus*.

Since my last letter I have opened and examined two nests of Nasutitermes (Eutermes), and found one queen in each. One nest was located on a dead prickly-palm tree about three feet above the ground, and was two feet long and eighteen inches in diameter, encircling the tree. The lower portion of the nest contained many eggs and larvæ; the upper and newer part, workers and nasuti. No winged ones, and no eggs near the queen. She was in a large cavity, surrounded by a host of excited workers, and near the centre of the nest. The second had a queen, eggs, larvæ, workers, and nasuti (soldiers with beaks) only. I

observed on the queen, with a small microscope, some parasites not discernible with the unassisted eye. She could move freely, with a peristaltic movement aided by the feet, and was about 25 mm. in length.

In adding fresh soil to my termitarium, there was a small beetle. The next day I found it on the surface with its legs, antennæ, and body so stiffened by the secretions of the workers that it could scarcely crawl; they evidently intended to cover it.

On the cocaloba (sea-grape) tree near our shops there is another species of termites, *Termes prælongus*, Beaumont; their galleries look like the Nasutitermes (Eutermes), but are different, and the workers smaller, more elongated, and the body of a chocolate color, with head, legs, and thorax white. Soldiers with long, slender, black, and slightly reflexed mandibles, colored like the workers, and have, when molested, a saltatory movement, jumping backward and forward from one to two inches; this seems to be done by their mandibles, bringing the points together and snapping them as one does the thumb and forefinger.

Last week I emptied one of my termitariums, about a month old, and found many young, of a transparent white, both workers and nasuti, in good health apparently. These must have been fed, though there was no sign of food or fungus. It is to this end that I am experimenting with my termitarium, to find out how the young and nasuti are fed, and have constructed one with a view to observe their inner life. They have such a habit of shutting themselves up that my plans keep changing. The light does not seem to trouble them so much as the breeze; they are sensitive to the slightest current of air, while a strong light focussed on them by a lens does not disturb them.

I have experimented to find if they hear as we do, or not, but have no results yet. Their sense of smell must be acute; no organ which we possess will compare with it in sensitiveness.

After watching their movements day after day, it is impossible to doubt that in the structure of the antennæ of the termites there must be some combination of the optic, auditory, and olfactory nerve which the microscope fails to reveal. We can then, in a measure, understand their peculiar and intelligent signs and movements; but how they are known in the antennal language, we, with all our knowledge, are unacquainted.

I observe they can detect vibratory movements that are not sensible to our ears or touch, such as the rubbing the outside of the smooth glass jar with finger-nail; this will arouse the nasuti quickly, and they will run around, sometimes stopping before a worker cutting wood, to give one of their expressive jerks of alarm, until the worker starts for cover. This movement is difficult to describe, but they balance themselves on their feet, and

jerk their bodies back and forth very fast; and the soldier, during this movement, ejects the glutinous liquid when attacked by other ants of its kind.

We have a coach under repairs now in which there is another variety of wood-ant, *Calotermes marginipennis,* Latr., which I have not observed before, and am surprised that they could get in the car and do so much mischief while it was in constant use; they had entire possession of the inside door-casing. I send you specimens, and you will find workers, soldiers, small queen (?), and perhaps males in vial No. 6. No. 5 are specimens called in my last letter "the jumping soldier." No. 4 contains two queen Nasutitermes (Eutermes), workers, and soldiers. The other centipede-like worms were found in the same nest as the queen; they dropped out in large numbers when the nest was broken. No. 2 are the specimens named by Dr. Hagen *Termes albidus,* Hagen. No. 1 were found in the nest where the six queens were found.

The block of balsa wood in which the vials are sent was in my termitarium about two days (forty-eight hours); you will see how they bored into it in that time. So far they have never eaten any cedar. The queens that have been sent you appear about the same in alcohol as when captured.

September 1st, 1888. I have now to record the capture of six queens, Nasutitermes (Eutermes), from one nest, all about the same size and general appearance, about twenty-five mm. in length and five mm. in diameter. This nest was located on the trunk of a palm tree, and sprouts were all through it, so that it was difficult to open it. The first piece cut was from the centre, about eight inches square, in which were seven queens; one was crushed with the machete. There were eggs and larvæ in every part of nest No. 5, and also winged ants. I started another termitarium with a part of this nest, and in about two hours, when they seemed settled and were working, I introduced one of the captured queens. They at once recognized it, and, to my surprise and delight, commenced to lick it clean, paying particular attention to its head, antennæ, and legs. About twenty of the workers were busy thirty minutes, while the soldiers hurried around in every direction, giving orders and calling for help to drag her into the nest. Like most queens, she had a will of her own and wished to go in an opposite direction; but the majority prevailed, with the friendly aid of the point of my pencil, in getting her into the cell, and at once closed the opening.

September 2d, 1888. To-day I cut up the rest of nest No. 5, obtained a week ago, and to which was returned one of the queens. It had been in a glass jar, and I was desirous to see what disposition they had made of the queen. Cutting with a saw and knife to

a cavity in the centre, I found four queens, much shrivelled and discolored, though they could move quite lively. Before disturbing them I placed cell and all on a clean board in the jar, to watch them. They moved around, apparently in search of a hiding place, always attended by a large number of anxious workers licking and caressing them, and whenever they stopped the workers would attempt to drag them to the cell. You will see that this nest No. 5 contained ten queens, and near them was a small insect of a shape unknown to me, neither worker nor soldier. It seemed anxious to be near the queen or the cavity, so that I call them "maids of honor" (Staphylinidæ).

Nest No. 6 was about two and one-half feet from No. 5 and connected to it by galleries, round in form and about two feet in diameter. It was well filled with eggs, larvæ, winged ants, and the usual proportion of workers and soldiers, but no queens. I think No. 5 was the parent-nest, and the eggs from the ten queens were carried to it through the galleries, as I have seen the eggs taken by a worker as soon as they were voided by the queen, and they give constant attention to her anal extremity.

I have not yet seen any signs of the nodules of prepared food mentioned by Hubbard, and am desirous to know how the millions of larvæ in nest No. 6 are fed.

While in Panama last week I obtained the seventh different species or variety. The nest was built of mud from the road, around the base of a telegraph-pole, and branches from it ran along the wooden railroad fence. Only workers and mandibulate soldiers were found in it. The latter have a different shaped head from the others; body is a dark slate color. These seven varieties of termites are under my microscopic observation and study.

In the report of the proceedings of the Philadelphia Academy of Natural Sciences, November 15th, 1887, there is the following allusion to the termites: "Rev. Dr. McCook referred to a communication from Mr. C. Townsend describing the nest of a white ant found in Honduras; wood pulp seems to be the material used, and the nests are placed between branches of trees."

Your conclusions about the different genera of termites constructing galleries are correct so far as my observations extend. The Nasutitermes (Eutermes) construct more extended galleries than any of the seven kinds of wood-ants under my observation, for some nests are fifty feet above ground, with galleries leading to them.

September 12th. I examined two nests on the beach. No. 8, a small one on a stump, contained about two dozen wingless ants, which I think were females, and I captured six of them. Nest No. 9 was about twenty rods away, and on top of a decayed root of a

tree. It was round, about two feet in diameter, and looked old. This was well supplied with eggs, and near the centre were six queens, somewhat shrunken and of a brownish-yellow color. (These are in the bottle with the six Staphylinidæ.) I took three of these queens, to experiment with those in my termitarium, under observation for three months. At 2 P.M. on the 12th of September, 1888, I put in a queen, which was received with attention, and caressed, washed, and apparently fed by both soldiers and workers; in a few moments it crawled into the nest and was lost to view. A female from nest No. 8 was well received. At 7 P.M. I introduced three queens and five Staphylinidæ from nest No. 8, about fifteen minutes apart. They were all greeted like the first, except more turned out to receive them. Very different, however, was the reception to a worker accidentally dropped among them. It was pounced upon and maimed, as were workers introduced for experiment.

After four days I dissected my termitarium to find the introduced queens. They were nearly at the bottom and centre of the nest, in a little hollow, and several of the Staphylinidæ also. Near by was a cluster of *new-laid eggs*, enough to cover a ten-cent piece. I looked at them with the magnifying glass, then carefully replaced the parts of the nest. They seem contented and do not try to escape.

September 15th, 1888. I send you, by Mr. Farrington, some samples of the work of Nasutitermes (Eutermes). The varnished piece is from a passenger-coach. The ants in the bottle came from nest No. 5, and have been under my observation for a week. The red paint shows the place in the nest where the queens were found, and you can see the sprouts of coca palm running through it. The Staphylinidæ—my "maids of honor"—are in a bottle (*Termitogaster insolens*, Casey).

September 21st, 1888. In answer to your questions received by the last steamer: 1st. With regard to finding a male attendant in the queen's cell, I have found several wingless ants in the large nests where there are several queens, but I am not sure they are attendants. Breaking into the centre of a nest is a slow operation and disturbs them and the wingless ants; male or small females are very active.

Oct. 2d. What were the parasites on the queen? They looked like minute lice, and lodged in the joints behind the head, and sometimes could be seen running over the body. To-day I noticed a worker acting as if in pain, and trying to attract the attention of its mates by violent jerks. Two or three came and licked at it, but did not seem to relieve it, when in desperation it rushed to a worker and licked it, and then held its head down for the same purpose. It also rubbed its head with its forelegs, then

ran around until it came near enough for me to use my double lens and see the parasite on its forehead between the antennæ, in what seems to be a dividing line. This parasite was brown in color, but about the same size as the white ones. I observe that the workers spend more time washing each other since the adoption of the queens, perhaps on account of these parasites. I have not found the nest of the "jumping soldier," but it enters the trunk around a decayed knot-hole. The limbs of this tree are all hollow—a naturalist's paradise; three species of wood-ants,—Nasutitermes (Eutermes), *Termes testaceus*, and No. 20, besides swarms of others.

There is something unusual in the termitarium to-day, September 21st, 1888, and it may be death, as I crushed many the time it was opened to see the queens. Six of the sexual individuals clustered together to-day, while the workers were apparently building an enclosure for them, which was finished in a few hours.

October 4th, 1888. I read the article in the *Scientific American* you sent me last steamer; it was in the main well written, though the observations have been hastily made. Some of the illustrations are wretched, particularly the worker. Such mandibles,—and showing them at work! The writer (or author) evidently never owned a private termitarium.

I have examined two more tree-nests with some profit, but have had an unpreventable mishap to my termitarium, and the little things seemed lost when turned out of it; and I have felt the need of the familiar object of study on my centre table, though I have gained from them much "food for thought," stored beyond loss. I often think, while riding by these unpretentious and apparently lifeless termite tree-nests that form such a conspicuous feature of the Isthmian landscape, how little people know of the hidden life within, of the well-regulated family of workers and young, guarded by a watchful army of soldiers, and whose chief centre of attraction and solicitude is a lovely queen pregnant with a progeny of untold millions.

To an intelligent observer and lover of nature there is a profitable train of thought in one of these skilfully constructed nests. The methodical habits; the covered galleries thronged with busy workers; the watchful care of the young by washing and feeding; and the solicitude for the helpless queen,—ready to die for her! It is marvellous, and shows a high degree of intelligence and affection. As a proof, my queenless nest, under my observation for four months, has adopted, without hostility, several queens and sexual individuals from strange and widely separated nests, even with amity and good feeling, while

workers and soldiers from the same nests were pounced upon and despatched as enemies.

January 14th, 1889. There are now two first-class passenger-coaches in the shop for repairs, damaged by the Calotermes, and in the same place as the other sent you,—the inside door-casings. This seems remarkable. The Nasutitermes (Eutermes) were at work (during my absence of two months) on a large pile of 1½-inch clear redwood stacked up in the commissary's yard, and of course cannot be destroyed without restacking the whole pile. They started in the *white-ash strips,* and did not eat the redwood. I saw a large pile of 6x10x20 yellow pine which the commissariat said "was excellent lumber, well-seasoned, stripped, and protected from fungus," but my experienced eyes recognized the Nasutitermes (Eutermes) at work on the ash strips, and with my umbrella I showed him that they were at work all through the pile, branching from the strips to the yellow pine.

The foreman in charge of the repairs on the inside of the church preserved for me a part of a plaster-of-Paris bracket eaten by termites, which is an interesting specimen, because they tunnelled the lower part, instead of running over the surface to reach the wooden pillar twelve or eighteen inches above. From the appearance of their work and the inconspicuous empty galleries, I think it must be *Termes testaceus.*

I have just made an examination of the bath-room in the superintendent's house, which was completely renovated a year ago, ceiled entirely with white ash, and varnished. All the termites were destroyed with kerosene, but no attempt made to find the nest. Now it will have to be entirely repaired, and I have advised the superintendent never to use another piece of ash in the house.

I have now two termitariums in which to continue my observations, which will be recorded and sent as you desired me to do.

The magnificent cocaloba (sea grape) tree on the beach is in full bloom, and I picked Mrs. Gen. Newton a bouquet from it to-day, as I did for Mrs. Dudley when she was here nearly two years ago. The knot-hole where the specimens of the vaulting soldiers were found has been taken possession of by *T. testaceus,* and the hole plugged up by them with earthy matter.

January 21st, 1889. The portion of rafter sent you was two feet longer on the eaten end, but dropped off in pieces when taken down. Both nests sent were in the timber. The life of the Nasutitermes (Eutermes) is gradually unfolding to me, and when we know enough to write their life history it will be wonderful. The workers in the communities have duties in excess of what first appeared before using the microscope. A

queen has been laying eggs for four hours under my observation, and averaged about *eight per minute*, one at a time, in rapid succession; then again slower, with periods of a few moments' rest. It is interesting to see the eggs, under the microscope, pulsating before the embryo ant can be defined. To-day I had photographed the largest Nasutitermes (Eutermes) nest yet seen by me; it was ten feet high, and in the corner of a shed. It will be a treat to break it up and see the inside.

The mud nest at Panama has disappeared, also the telegraph-pole. Query: Which went first? There is a new pole about a rod distant. A few miles north of Panama I found another conical mud nest, about three feet high and three feet in diameter at the base,—without doubt the same species as the former.

The stairs leading to the church-tower are built principally of Spanish cedar, with some pine. The ants eat the latter close to the former without touching it in a single instance, nor has the Spanish cedar decayed at all. I enclose a fine piece of veneer by the master-worker Nasutitermes (Eutermes); it is the remains of the upper side of a lime-barrel head,—the lower side was the same,—also a piece of stave from the same barrel.

February 3d, 1889. Last week I had to go across the bay to "Kenney's Bluff Waterworks," and went into the mountain, and in a short time found a termites nest similar to the fragment sent to you; it is the only kind that is not a Nasutitermes (Eutermes), brownish in color, with smaller septa. I was fortunate in securing the queen and the nicely constructed cell,—not a "cavity left among the septa," as one writer says, but a roomy cell that you will be delighted to see. The queen resembles those of the Nasutitermes (Eutermes) in general appearance, the abdomen of finer texture, head and thorax smaller in proportion. Only one soldier was captured, but many workers and immature winged ones.

This morning, taking the advice of Solomon to go to the ants and consider their ways, I opened two Nasutitermes (Eutermes) nests, made observations, and took a queen from each. In the centre of one nest a twig of a dead shrub had been incorporated, about one-half inch in diameter; the centre had been eaten to the thin bark, and here was the queen fitted nicely in her bark house.

This nest,—illustrated in February number *M. Journal*,—I found on the beach this morning, built on the dead trunk of a small tree, about two inches in diameter and about eighteen inches above the ground. The trunk was honeycombed by the ants, and I broke it off close to the ground and put it into my six-by-nine glass jar, two-thirds full of moist soil around the trunk, with two white-ash braces, and all standing in a wash-bowl

partly filled with water. This is the *ne plus ultra* termitarium; its census has not yet been taken, but it must be in the millions, as they are swarming over the surface of the soil and pieces of ash for food, and delving down, seemingly to find the foundation of their new home. I have mounted three termite parasites on one slide, taken from the queens captured to-day, and they look well. The glycerin jelly is better here than the Canada balsam.

February 14th, 1889. Your letter, with a copy of one from Dr. Hagen to you, came last steamer. He seems to be puzzled about species. When I am dissatisfied with the progress of my observations, it is comforting to know that he is in the same dilemma and is making haste slowly. I send you two photographs of the large nests, one of which please give to Mr. Riederer. When I think of the immense weight the little workers have eaten and digested beyond what was necessary to support life, it is astonishing.

Capt. Lockwood, Mr. Clark, and Dr. Sturgis, officers of the *City of Para*, were interested in seeing the two rows of soldiers, ten inches long, with the little workers between plodding away in single file building galleries, and all expressed their admiration and astonishment. I will send you by them another sample of the *Calotermes marginipennis* found in the seat-frame of a first-class coach. There were twelve seats damaged, and we cannot explain how they got there; and thus far none have been found elsewhere.

There has come to me to-day a curious nest occupied by black ants, built of mud and some glutinous substance, and stuck on a twig of an orange tree; it is about three inches long, globular in shape, with a number of holes for entrance, one-quarter inch in diameter, and heavy for its size.—evidently a hornet's nest.

The Nasutitermes (Eutermes) in the "*ne plus ultra*" have built two bridges, running the gallery over the top, and started the third one to-day and running it underneath. I have found a nest with *twenty queens*, about three-quarters of an inch long, and think it must be a parent of several nests. With a block of a Nasutitermes (Eutermes) nest I tried the experiment of wrapping it in a damp towel. After forty-eight hours I unfolded it, and found they had eaten their own nest and rebuilt or covered up the ruptured passages.

I send you with the photographs some native oak, also the seat-frame eaten by Calotermes, and suggest that you cut it up, for fear there may be live ants in it.

March 12th, 1889. To-day, on the steamer *Newport*, a gentleman from Peru gave me an account of the Calotermes work-

ing in his trunk. He discovered them first by the little round pellets of refuse that they pushed up as they were working downward through the cover of his trunk. He described them as white, and some of them had short wings. If this is true, it is easy to account for their finding a home in our coaches, as you suggested. He knows the Nasutitermes (Eutermes) by their nests and galleries, but has not observed them in Peru or the high lands of Mexico. This confirms a conclusion that their habitat is governed by altitude as well as latitude.

March 23d, 1889. Another passenger-coach has come to the shop for repairs; end sill decayed, door and window posts of one end eaten by the *Calotermes marginipennis*, one tenon eaten off entirely. Took out the whole end of the car and found some nymphæ among them. Yesterday the carpenters tore down a part of balcony considered unsafe in the rear of superintendent's house and near the bath-room, and found a Nasutitermes (Eutermes) nest between the floor timbers of the second story. This explains the work of these ants on the ash ceiling of the bath-room.

There is a part of a decayed log in our lumber-yard that is in possession of the vaulting termites; it also contains eggs and nymphæ, but have not yet found a queen. My clerk says that he visited the photographed nest and found the ants rebuilding, having covered the top, on which was poured carbolic acid.

April 2d, 1889. I am now making observations of the *Termes prælongus*, Beaumont (jumpers), and have found a branch nest of this species in the old stump, but think there is more of it. I have obtained some winged jumpers just able to fly; they would no doubt be able to swarm next month. They are much smaller than the winged Nasutitermes (Eutermes) or *Termes testaceus*. In breaking the nest in the stump, in pursuit of the queen, I found thousands of young workers, but very few soldiers; many white nymphæ with black eyes. Fresh eggs were numerous, but no queen visible. I think she will be smaller than the Nasutitermes (Eutermes), and, from the trouble and labor in search of her to date, she ought to have the financial value of an eagle. To verify my conjectures in regard to the feeding of the young of this species, I placed fragments of the nest in a clean jar 6x9, without any soil, the bottom of the jar being slightly convex.

The baby termites travelling about the ruptured nest dropped from above to the bottom of the slippery jar, and gravitated to the lower edge in large numbers, and were unable to climb to the nest, which rested on the centre of the jar; so the little mites huddled together, and the workers came down to them, and

as soon as they felt them approach they made an effort to get to the workers' mouths; sometimes two or three struggled for the pap, so that after watching them I have no faith in the "fungus theory." For these frail, transparent young could not nibble the hard nodules found in the Jamaica tree-nests. I do not say that this material is not used as food for young termites, but that the young are unable to make use of it themselves. I have never yet found fungus of any kind in the nests, and besides have mounted some young, and can see under my microscope, in the gullet and abdomen, food-grains of a more solid nature than fungus. Hence this conclusion: that they are fed by the workers with food prepared as wanted by them; and I doubt whether any other person has ever had the rare chance of seeing these little young termites as I have seen them during the past few days.

April 14th, 1889. I have been in the jungle and made additions to my collections,—notably two Staphylinidæ and one white ant guest. Many decayed stumps were swarming with the *Termes prælongus*, Beaumont (jumpers), but so far have not found a queen,—though I have all others of that species, from the eggs to the perfect winged ones,—and find that *T. prælongus* workers eject cement from the abdomen to cover their work, similar to the Nasutitermes workers. So far no galleries have been found; they seem to cover entirely, that is, the rotten stump. From three Nasutitermes (Eutermes) queens I took off eight parasites, and mounted all on one slide in balsam.

Further observations of Nasutitermes (Eutermes) queens during oviposition show two apertures at the extremity of the abdomen; from the upper is emitted the watery discharge, which is in periods of a minute, the fluid trickling upon the eggs discharged from the lower aperture and keeping them moist. Please mention this to Mr. Riederer, as it may be important in the study of the anatomy of the queen.

On the 12th of April, 1889, I witnessed the first swarming of the winged Termes. The first rain of the season, of forty-eight hours, had abated; at 3 P.M. the air was still, and I predicted the appearance of the winged ones before sundown. At 4 P.M. there was a swarm of swallows near our paint-shop, and the winged ants were swarming from the ends of the coal-bin timbers at the rate of about one hundred a minute. They were the *Termes testaceus*, and came mostly from a crack in the end of a 12x22 timber. Around this crack were the soldiers, with heads out and mandibles open, and when touched would eject their milky fluid. They seemed to guard the entrance against enemies, and it was interesting to watch the winged ones squeeze out by them, the soldiers remaining motionless. Many were captured on the

wing by the swallows, and others were carried off, as soon as they alighted, by the common ant. At 6 P.M. they stopped issuing from the cracks, and the openings were sealed, and no more from this colony have since come.

We still find the Calotermes in our coaches. People here, in hearing me speak of the ravages and insatiable appetites of the termites, ask if it is new, as they never before heard so much complaint. They have been blind or heedless to the destruction they caused, for the termites were here to greet Columbus, and the teredo destroyed his vessels.

April 14th, 1889. I was in the jungle to-day, and found the central part of several Nasutitermes (Eutermes) nests containing the queen cell. I split one open lengthwise and took out all the termites. A few days later, while searching other nests, obtained at the same time, for Staphylinidæ, many eggs and workers were jarred on to a plate with dirt, and then thrown into an empty jar to destroy. Noticing the workers picking up the eggs, I put the empty block of nest in, to see if they would use it for a repository for their eggs. This was at night, and in the morning, upon raising the upper portion of the nest, I found every egg had been removed, cleaned, and stored on one side of the queen's cell. Now, these Termites had been without food for five days,—unless they had eaten their nest,—and been much disturbed, yet at the risk of their lives they had saved the eggs from destruction.

April 22d, 1889. To-day I investigated the seat-rail, companion to one you sent in February. This had been jarred to get out the Calotermes, and I did not expect to find many. I sawed it into lengths of five inches, jarred a piece endwise into a glass dish, and out flew a perfect winged one into the room; it was secured. From that seat-rail—supposably empty—I got about 1,500 nymphæ, 14 soldiers, and 72 perfect winged ones; the latter were active, and some escaped. I was particular to count them from each piece, to get the proportion, and noted the small number of soldiers. The winged ones are smaller and shorter than the nymphæ, and there is a difference in the venation of the wings between this species and the Nasutitermes (Eutermes), and when mounted are transparent and reflect colors under the microscope. Do you know whether Dr. Hagen has any of these in his collection? Because their habits are so retiring it makes them seem rare. A very young queen was found and has been placed in a jar with some of the wood for further developments.

April 24th, 1889. My observations to date show only two species that construct long galleries,—Nasutitermes and *Termes minimus*. The next species among the architects is *Termes*

prælongus, but they try to cover their work, leaving a space behind the plaster about three-sixteenths of an inch. The *Termes minimus* often construct as you illustrate, but frequently like the Nasutitermes. I have five Staphylinidæ from the last Nasutitermes nest, and also two of the little white guests; these seem to be the only strangers met with in the central part of these nests.

From further observations on the *Calotermes marginipennis*, I assure you and Dr. Hagen beyond doubt that the imago does have a lobe between its claws, by which it can run up and down a window-pane or the vertical sides of the glass jar in which my first specimens were with difficulty placed.

This power, that other species do not possess, reminded me that Dr. Hagen is recorded as searching for it, but did not find it, and that you had found the rudiments of a lobe in a nympha. The Doctor's specimens may have been imperfect, for a side view of the foot shows the lobe or sucking disc.

Other results of observations of this species are that they have no workers, that the nymphæ while young have no visible signs of eyes, wings, or lobes between the claws, therefore they cannot see, fly, or crawl on slippery surfaces, nor have they any use for these organs at this stage of life.

The nymphæ at first are like grubs, fat, sluggish, and repulsive to the eye; they gradually change, while performing destructive work, to perfect insects,—black eyes, graceful bodies, iridescent wings, lobed feet, and beautiful to the eye. Imagine, if you can, "the swarming" of thousands of these *Calotermes marginipennis* issuing forth from the seat of a passenger-coach in motion, on any of the trunk lines in the vicinity of New York! I wish you would show Mr. Adams, the Boston & Albany's car-builder, the work of these pests in my coaches, for in spite of all I can do it seems impossible to get rid of them.

May 2d, 1889. I am now observing the *Calotermes marginipennis*, and find them as interesting as the other species, while their habits are different. In a first-class coach in the shop for repairs, the Calotermes are at work in two places, and the seat-rail is a fine specimen of their carving.

I observed the cutting and masticating process of the jaws. The toothed or anterior portion of mandible is used in cutting and tearing the fibres of wood, and the posterior is for grinding and masticating it. To observe this I made a calotermitarium which has answered the purpose, by placing a piece of seat-rail one and one-half inches long, with a pocket in which were a few *Calotermes marginipennis*. Then with a penknife I drilled a hole endwise in the block about one-quarter of an inch dia-

meter and three-eighths inch deep; then with a camel's-hair pencil, moistened at the tip, I lifted seven to the edge of the hole. They enter head foremost and work at the bottom, seeming contented. Among them is one soldier,—one imago of a brown color without wings. By placing this block on the stage of my microscope, with a two-inch objective, there is a good view of the workings of the mouth parts, especially as they are slow in the movements of their mandibles. I note that when sleeping or resting the anterior part of mandibles remains partly open, while the posterior part is closed. When the mandibles are at work they have a cam-like movement, thrown outward while coming together.

Another strange thing is that they have two secretions from the abdomen, one the hard, round pellets, and the other a soft, pasty substance which is eagerly devoured and also used as a cement. They not only take it from each other, but double up and take it from themselves, and then slowly work the mandibles until it disappears. Query: Is it possible that the ligneous food has to pass through the system twice before it can be perfectly assimilated ?

I am pleased with the confidence you expressed in your letters in the truth and correctness of my observations, and their value scientifically and financially. Your appreciation of my difficulties in the decay of wood in this climate, and knowledge how to check it, suggestions and assistance about the termites, have been to me a great benefit.

I send you another balsa block containing four vials. No. 101 contains eggs, soldiers, workers, nymphæ, and immature winged ones of *Termes saltans;* No. 100 are beautiful specimens of perfect winged ones, *Termes prælongus;* No. —, perfect winged imago Calotermes. The vial without number contains what I got out of coach in shop for repairs.

I shall be pleased to read Capt. Casey's description of the "maid of honor." I have only seen so far this season two "marriage flights" of the Termes, and it seems to me to be a sentimental description of the dispersion of the sexes from the parent-nest, for at this time, in my observations, the congress of the sexes seems to take place in the nest, and previous to swarming, to form other colonies. They have enemies; the flight is of short duration; no time to waste on the uncertain congress of the sexes on the wing, as they seem to hie to cover as quickly as possible, and it is more in accordance with Nature's laws that the female should issue forth from the parent-nest in a perfect condition to form another colony.

May 14th, 1889. The interesting monograph, "Termitogaster insolens," by Capt. Thomas L. Casey, is just received, and it is the finest collection of descriptive words that I have seen, and I hope to have a description of the other termite guest—the white one—which is found among the *T. testaceus* also.

The timbers under the water-tank that stand on our coal-bin were much decayed. They were of sound yellow pine, and had been in use for five years. The weight of the tank had squeezed them together an inch, and on taking them out there was a premature flight of *T. testaceus* at the same place as one described to you a month ago. It is evident from this that there may be several swarms in one season.

The Rev. Mr. Geddes, from Jamaica, in looking at my calotermitarium, said he had frequently seen the same work there on ash and kindred woods, but they called it "dry rot" and did not think it was the termites. I showed him a bottle containing about 2,000 Calotermes taken out of one piece, and it convinced him, and he intends to send me some observations.

My Calotermes are a happy family. I can coax them out of their nest to have their heads and faces smoothed and washed with a moistened camel's-hair pencil, and sometimes they will playfully take the pencil in their mandibles if I press too hard. When fully developed they have perfect *wings*, *eyes*, and *lobed feet*, and I have a perfect winged one, or imago, that shows reflected light under the microscope, while the nympha does not.

May 24th, 1889. There is so much of interest about the termites that I am bewildered with astonishment and scarcely know where to commence or end. I am glad to hear that Mr. Riederer's careful studies and dissections of the nymphæ confirm my observations in relation to the gradual development of the *C. marginipennis*, and it is probably gratifying to him to know that our conclusions are the same, reached, as they are, from different methods of study,—his from the dead specimen, and mine from the living in its habitat.

I have found another parasite feeding on the dead Nasutitermes (Eutermes) in my termitarium. It is horrible-looking, with claws on its feet, and hairs on the abdomen larger than the first parasite noticed. There are hundreds of them, and as there are only a few soldiers and one Staphylinide, it may account for their increase, as the latter may prey upon them in some stage of growth.

As the calotermitariums are deepened and out of the focus of my microscope, I start others on the surface, and move my

tame Calotermes into new quarters for better observation, without any difficulty. If at first they attempt to leave the hole started for them, I can drive them in with a camel's-hair pencil, and now have some of the smallest termites (Nos. 34 and 35) under observation.

Yesterday I saw a termites nest on some blocks of masonry about eight feet square, built about six years ago on wooden ways, with the object of launching to form a breakwater, which was not done. The Nasutitermes (Eutermes) got into the wood, and hence the nest against the masonry. They are different in color from any species yet collected, being reddish.

I do not think that there is a stick of decayed timber in our shop-yard that has not received a stab from the blade of my knife or point of my umbrella; and to-day, in passing a decayed fence-post, I split off a portion and found two wingless termites close together. They proved to be Calotermes, and I prepared a block of ash one and one-half inches square, bored a hole in it, and in thirty minutes they were busy eating and smoothing the sides of their new nest, and have allowed me to wash them with a hair pencil. They have two white ocelli over their black compound eye, and I can see rudiments in the nympha. They are valuable acquisitions to my termitarium for observation, because they are quiet and amiable. They have lobed feet, the lobes being quite prominent. There was no other termite of this species on the post; they seemed to be alone, and may have fallen during the marriage flight. There were a few common ants near the foot of the post, which had a nest with eggs and larvæ.

I have recently discovered a number of nests of termites of the mud-nest species on a plain of pasture. They are of all sizes from three feet downward. The tops of the nests are watch-glass shape, and have so far only been found near Panama.

Your advice to use California redwood was judicious, for so far I have not found the termites eating it, and it does not readily decay.

June 4th, 1889. The captured queens *C. marginipennis* are doing well in an ash block that can be opened lengthwise. They laid three eggs after a week, and as two disappeared I separated them. They show no disposition to leave the cell under my scrutiny, but keep turning the eggs,—showing that the queens of this species take care of their own eggs in the absence of the workers, and therefore the number of eggs of each queen is limited. When it is understood that every termite that comes to maturity, with the exception of a few soldiers, is

male or female, the latter may exceed in number the other species, and thus make up for the small number of eggs to each queen.

My observations here on the Isthmus of Panama do not confirm the fungus theory, applied to these termites, as the origin of the pellets. I think I have seen them voided. I have prepared a longitudinal section of a short piece of a seat-rail containing a few nymphæ of *C. marginipennis*. In a few days some of the little pellets were pushed through a little hole at the rate of thirty or forty per minute. These pellets are usually the only outward sign we have of the inward presence of this species. In the above section of seat-rail there are three pockets filled with pellets, partly to get them out of the way and to prevent the entrance of intruders. And in another pocket is a pin-hole, made for getting rid of the refuse; and you would have smiled to see the neatness and despatch of the operation.

I was invited to Panama to inspect a set of imported furniture ruined by *Calotermes marginipennis*. When I broke off one of the legs of a chair, the winged imago flew out very lively. The owner said the wood was European hickory. I also saw an ash extension-table affected by the same species, for which so far no remedy has been found.

June 2d. I opened some mud nests and made close observations of their contents, and secured imago, two queens, and several *virgin queens* (auxiliary queens), and for the first time found two species of termites occupying different portions of the same nest. I have hunted for this in the hundreds of nests examined of other species, and this mud nest confirms what Dr. Hagen has stated. The only species of strangers I find in the mud nests is the smallest termite yet seen here (*Termes minimus*), and the difference between the two kinds could be easily noted. In the six nests opened, the *T. minimus* was found in three out of the six. Some of the eggs were found, showing that the queen was not far away. These *T. minimus* live in septa or cells connected by small galleries, completely shutting out the rightful owners. These septa and galleries are lined or whitewashed by the strangers with their secretions; so, upon splitting open a portion of the nest, wherever the white cells appeared there were the *T. minimus*, so that there was no intermingling of the two species. The septa not occupied by the strangers were the natural color of the mud—red clay. The white lining of the septa under the microscope shows the work of the *T. minimus*. Twice when the nest was opened I saw the soldiers of the mud nest besiege the strangers, but no sign of any further hostility was shown.

I also found what I at first supposed was the trunk of a dead tree, about four feet high, looking as if coated by the mud ants, but examination showed that it was a column of mud. In this I found a few *T. minimus* contesting possession with the mud ants, *T. columnaris*. I took a piece of the columnar nest and planted in my garden for observation. The whole nest was about four feet high, six inches diameter at top, and about fourteen inches at base. I sawed off a section. The *T. minimus* were not found inside this column, only on the outside. I am positive there is no connection of septa or galleries between the two kinds of termites. I was hampered in examination of mud nests in the open savanna by the hot air, my umbrella, spectacles, bottles of alcohol, and eyes blinded with perspiration. I found no queen cell in the mud nest, and the little, undeveloped queens found are *white, slender*, and without the colored bands on the abdomen of the Nasutitermes (Eutermes), and were found on the ground, in the hole made in opening the nest. One of them is nine mm. long, the other seven mm., and nearly three mm. diameter through abdomen, and, while of the same general form of the Nasutitermes (Eutermes), are smaller.

If I should write you all the interesting things I see among the termites, it would read like a Munchausen story, and therefore you only receive from me plain facts of observation. I will write you my experience with a large black ant in my termitarium, which I captured in its nest in my garden with three grubs or larvæ. I put it in a vial one and one-half inches long and half an inch wide, without neck, and kept the cork in for thirty minutes. It began to clean the larvæ, so I took out the cork and laid the vial horizontally in the bottom of a jar. In ten days she has been seen out only five times; one of the larvæ has passed into a pupa, the second is growing, and the third died and was buried or eaten. The ant has laid seven eggs, and is attending them while feeding the larvæ, and has nearly filled the mouth of the vial with grains of sand and soil, leaving just space to go in and out, but does not attempt to run away. Whenever I find her out, when approaching with my hand lens, she rushes to her nest, and with her long, elbow-like antennæ gently touches each egg, larva, and pupa to see if they are all right. I feed her on mosquitoes, termites and their eggs; and this noon I saw her holding one of the latter up to the mouth of the larva, but as it did not take it she laid it down within its reach. A hen brooding its young never showed more anxiety than does this ant in watching hers. If I touch the glass gently, the tips of her antennæ will touch each one to see if any injury has been done. I never find these ants in company with others of their species. Are they not all a fascinating study?

You were right about the queen of the *C. marginipennis*. I have had a nympha pass from that condition to a perfect imago in the calotermitarium, and then to a queen, and now expect her to lay. I have six calotermitariums under observation. I have some *Termes minimus* making small galleries for me, and have one of their queens in her own cell under my observation, having made a glass window to it; they soon drew over it a curtain of cement, but what I saw was wonderful.

June 14th, 1889. To-day I have a man, with a bucket of fernoline and a long syringe, trying to destroy the *T. testaceus* in our lumber-house. They are in it in large numbers, and I am daily convinced of the rapid destruction here of lumber and buildings by the united action of termites and fungus. I have under observation some bumpers made about four years ago, of sound yellow pine and tarred. Now I can crumble them in my hand. So far the Nasutitermes (Eutermes) and *C. marginipennis* are the only termites that attack *sound* lumber under my observation *here*, as I have never found *T. testaceus*, *T. prælongus*, or *T. minimus* at work on any other than decayed wood. Nasutitermes (Eutermes) are commonly found on decayed wood, and *C. marginipennis* on sound lumber.

While over the railroad yesterday I noticed at San Pablo two storehouses owned by the Panama Canal Company had collapsed from the effects of termites; the roofs had fallen, while the gable ends were standing. At the Fox River shops I found last week the man in charge burning Nasutitermes (Eutermes) nests found in the numerous buildings, and he had a large bonfire of them.

I was interested to read of your interview with Dr. Hagen in the Agassiz Museum at Cambridge, and wish I could have been with you to see the doctor and his collection. I send thanks to him for the African specimens, *T. bellicosus*, he gave you to send to me.

In an old Nasutitermes (Eutermes) nest from Frijoles I found a number of Staphylinidæ, and other varieties of ant guests. I took many hours in examination of this nest, and the centre vial—No. 20—contains five specimens of new ant guests unknown to me, and they may prove to be male Staphylinidæ. When it was jarred on a white plate while running, it carried the extremity of the abdomen turned over until it touched the thorax; but when touched it would work it back and forth as though getting something from it. Being active, it was difficult to capture, and seemed to be on intimate terms with the workers and soldiers; as also the Staphylinidæ, running to them for protection and seeming also to converse with them.

No. 22 contains two more kinds of ant guests from the same nest, three dark ones and one lighter in color; the former may prove to be the imago of the white guests, which you say are nymphæ. Please send some of these to Capt. Casey.

No. 20 contains five Staphylinidæ and a number of white guests. I hope these will reach you, as I was at some pains and trouble to get them and may not be able to replace them.

No. 23 are not from the Frijoles nest; I retain those Staphylinidæ here. No. 13, *T. testaceus* imago; No. 17, Nasutitermes (Eutermes) imago; No. 35, imago, workers, nymphæ, and a virgin queen from Corozal mud nest, and forty eggs from the same. This is a fine collection. The long vial is a worker Nasutitermes from my termitarium that is covered with parasites; they are on its body, legs, and antennæ.

Like you, I have also found a male *C. marginipennis;* its color is different, like old gold, and the thorax of different form and about seven mm. in length. It was found with a queen in the dining-table from Panama.

The largest number of eggs *C. marginipennis* queens laid under observation has been three; the first one laid is cared for by the queen like a hen with one chicken. I am anxious to see signs of life in the egg, and when I take it and put it under the microscope the queen soon misses it and leaves her cell to hunt for it.

June 23d, 1889. I have a new "*ne plus ultra*" calotermitarium,—an ash block three inches long, one and one-half wide, and one deep. A microscopic glass disc is fitted on the upper surface in a groove; under this is an excavation of three-quarters of an inch in imitation of the natural pocket this termite makes. I have six of these blocks numbered and contents noted. One has queens, nymphæ, males, soldiers, and larvæ; another, fresh-laid ova; a third, nymphæ that have shed the skin and emerged to beautiful imago. Two metamorphoses occurred last night, and I have mounted the skins. These old skins crack lengthwise of the abdomen; then the white imago backs out, leaving a perfect shell of mandibles, maxillæ, palpæ, legs and claws with indistinct lobes. One of the mounts shows all this, even to the cutting edge of the mandible. The young larvæ follow the nymphæ and take their pap from the extremity of the abdomen. No fungus in this dry wood, and the baby termites feed the same as the older ones do.

Rev. Mr. Geddes brought me some specimens this week from Jamaica of *C. marginipennis*, with this statement: These specimens were taken from a white maple board used for slicing bread about three years. He noticed a few pellets, and upon

splitting the board found a pocket full,—several hundred nymphæ and six soldiers. One-half the board he brought to me. The board is about ten inches in diameter and has been turned in a lathe. The nympha looks like the car *C. marginipennis*, but the soldier is different, with a dark body like the mature queen, head and mandibles darker and of different shape. I put an Isthmian nympha with four Jamaican, but they locked jaws and it was soon *hors de combat*. As I have never seen the Isthmian *C. marginipennis* quarrel, though mixed up from different localities, it is possible that these from Jamaica are of another species.

This morning I opened a tree-nest of Nasutitermes (Eutermes) from Frijoles. The septum of the interior was very fragile, while the outer portion was thick and tough. The nasuti had red heads, and the few imago captured had brown wings. Interior of nest brownish-colored; evidently another species. The queen was of the usual form. Did you note the coincidence of our letters in explaining Fritz Müller's composite nests? I have already told you of finding two species in one nest, one an interloper adapting a part of the nest to its own use, although it had not constructed any portion of the nest.

July 2d, 1889. In passing the sea-grape tree to-day my eye caught some fresh pellets in a depression of the trunk, looking like those of *Calotermes marginipennis*. I cut a piece of the bark, made a hole with forceps, picked out a soldier and worker; the former is a *C. marginipennis*, and the latter looks like *T. testaceus*. In a few moments I had specimens of three different species, taken within an inch of each other, and tracks of Nasutitermes (Eutermes) were near.

I also found near the Mechanics' Lodge, on a fence-rail, a new Nasutitermes (Eutermes) nest, and on taking it down there was a teaspoonful of fresh eggs on the rail. In splitting open the nest a plump young queen about an inch in length dropped out.

I am now studying the number of times the *C. marginipennis* moults before reaching the imago. Some of the moults have wing-cases and others have none. I have seen the operation under the microscope, and have assisted some of them through the ordeal, and they are also helped by the nymphæ. It takes about fifteen minutes, and is wonderful to see through the glass. I have no doubt but what the nymphæ of all termites undergo similar progressive metamorphosis, but, from their nature and habits, cannot be so closely observed. I have now twelve blocks of them under glass, and can put them under the microscope at any time.

I was glad to read in your last that Dr. Hagen modifies his assertion relative to several species occupying the same nest, and that my explanation agrees with Fritz Müller's. I have the two species at work together in two glass jars with a bridge connection, and they both have built an independent gallery on the underside, and this is a curiosity.

July 4th, 1889. This morning, while probing the cocaloba tree on the beach, my knife entered a cavity and exposed a household of termites,—two sexual individuals, with a family of eight small larvæ. I hurried them into my termitarium to make an examination, and believe that I have father, mother, and eight children—*larvæ*. What a find! They had evidently just commenced housekeeping and are Nasutitermes (Eutermes). Their little house was an excavated globular cavity, about three-eighths of an inch diameter, in the thickened, gnarled bark. At first I could not believe the little ones belonged to them, but as soon as I put them on a saucer with a small chip of the bark, they both picked up the little ones on the chip and commenced to wash them; that decided the relationship. I prepared an ash block by making an excavation and placing in the bottom a piece of their tree-nest, being careful not to touch it with my fingers and so destroy the smell of their old home; and they now have the choice of a bark or ash cell with a glass roof, and have taken possession and seem contented. The imagos are about seven mm. in length, two and one-half mm. diameter. One has a white longitudinal stripe on the sides of the abdomen, the other has a yellow stripe, and the latter seems to be the male. Otherwise they look alike, and on my last view of them they were both washing the babies. Is it possible these eight larvæ, one and one-half mm. long, are from the first eggs laid, and then a rest? I await further observations of them with great interest.

This morning at 4 o'clock I looked at my blocks of termites and found a nympha with short wing-cases had just cast its skin, and I mounted it. You see they have to be constantly watched to find them in the act of moulting, and I desire to see those with the long wing-cases moult, to note the difference in appearance afterward.

Mr. W. H. J. Sieberg exhibited specimens of pottery exhumed in ancient graves at Inwood, N. Y.

The Secretary read the following paper by title:—

CONTRIBUTIONS TO TEXAN BOTANY.

BY N. L. BRITTON, PH.D.

Additions to the List of Plants collected by Miss Mary B. Croft at San Diego, Texas.[1]

189. *Clematis Drummondii*, Torr. & Gray.
194. *Cocculus diversifolius*, DC.
215. *Malvastrum Americanum* (L.), Torr. (*M. tricuspidatum*, Gray.)
214. *Abutilon Wrightii*, Gray.
199. *Melochia pyramidata*, L.
192. *Corchorus pilobolus*, Link.
198. *Tribulus maximus*, L.
197. *Larrea Mexicana*, Moric.
196. *Talinum patens* (L.), Willd.
123. *Porliera angustifolia*, Gray.
23. *Indigofera leptosepala*, Nutt.
190. *Mimosa malacophylla*, Gray, var. *glabrata*, Benth.
187. *Lythrum alatum*, Pursh., var. *linearifolium*, Gray.
200. *Mollugo verticillata*, L.
203. *Evax multicaulis*, DC.
216. *Pyrrhopappus multicaulis*, DC.
225. *Baccharis Texana* (T. & G.), Gray.
222. *Zexmenia hispida* (H. B. K.), Gray.
288. *Helenium microcephalum*, DC.
207. *Centaurea Americana*, Nutt.
114. *Sonchus asper*, Vill.
209. *Asclepias verticillata*, L., var. *subverticillata*, Gray.
12. *Phacelia congesta*, Hook.
220. *Solanum triquetrum*, Cav. (also 218).
210. *Dianthera parvifolia* (Torr.), Gray.
208. LIPPIA LIGUSTRINA (Lag.). (*Verbena ligustrina*, Lag. Gen. & Sp. 18 [1816]; *Lippia lycioides*, Steud.)
20. *Verbena bipinnatifida*, Nutt.
211. *Herpestis chamædryoides*, H. B. K.
223. *Amarantus fimbriatus*, Benth.
224. *Acleisanthes Berlandieri*, Gray.
195. *Guilleminia illecebroides*, H. B. K.
202. *Euphorbia albomarginata*, T. & G.
204. *Jatropha spatulata* (Ort.), Muell., var. *sessilifolia* (Hook.), Muell.
206. *Croton glandulosus*, L., var. *septentrionalis*, Muell.
205. *Croton argyranthemus*, Michx.

[1] Published in TRANSACTIONS of the Academy, Vol. VII., pp. 7–14.

212. *Croton gracilis,* Muell. Arg.?
201. *Ephedra antisyphilitica,* Meyer.?
149. *Tradescantia Virginica,* L.
186. *Agave Mexicana,* Hook.
182. *Cyperus cyrtolepis,* Torr. & Hook.
181, 183. *Cyperus uniflorus,* Torr. & Hook.

The following Gramineæ were determined by Dr. Geo. Vasey:—

255. *Panicum subspicatum,* Vasey.
256. *Panicum autumnale,* Bosc.
240. *Panicum capillare,* L., var. *acuminatum,* Vasey.
232, 241. *Panicum Reverchoni,* Vasey.
226, 242. *Panicum lachnanthum,* Torr.
234. *Panicum Texanum,* Buckl.
238. *Paspalum pubiflorum,* Vasey.
229. *Setaria caudata,* Griseb.
252. *Rottboellia corrugata,* Baldw.
233. *Eriochloa sericea,* Munro.
239. *Heteropogon contortus,* R. & S.
251. *Andropogon scoparius,* Michx.
228, 246. *Andropogon saccharoides,* Sw.
230. *Stipa setigera,* Presl.
249. *Trichloris pluriflora,* Fourn.
254. *Buchloë dactyloides,* Engelm.
253. *Bouteloua trifida,* Thurb.
248. *Bouteloua hirsuta,* Lag.
231. *Bouteloua Texana,* Wats.
235. *Pappophorum apertum,* Munro.
227. *Triodia eragrostoides,* Vasey & Scrib.
250. *Triodia albescens,* Munro.
243, 247. *Triodia acuminata,* Vasey.
236. *Diplachne dubia,* Benth.
237, 244. *Eragrostis minor,* Host. (?)
245. *Eragrostis oxylepis,* Torr.

Corrections to the previous list:

133. "*Helenium amphibolum*" is probably a small form of *H. nudiflorum,* Nutt.

96. "*Hymenatherum tenuilobum*" is *H. pentachætum,* DC.

43. Misprinted "*Cardamine,*" etc., is THELYSPERMA TRIFIDA (Lam.). (*Coreopsis trifida,* Lam.; *Thelysperma filifolium,* Gray.)

Gaillardia suavis, printed as No. 131, should be 113.

Evax multicaulis, printed as No. 72, should be 203.

Thamnosma Texanum, printed as No. 81, should be 204.

25. *Croton capitatus?* This is the same as Berlandier's No.

649 and is not that species. It is perhaps undescribed, but near *C. monanthogynus.*

Note on some Plants collected by Mr. Frank Tweedy in Tom Greene Co., Texas, in 1879.

Clematis Pitcheri, Torr. & Gray.
Delphinium azureum, Michx.
Polygala verticillata, L.
Polygala alba, Nutt.
Polygala puberula, Gray, fide S. Watson in litt. But I do not see how the specimens can fairly be referred to this species. The plant produces cleistogamous flowers, after the manner of *P. polygama,* but on branches from the base of the stems, although not subterranean. The pods from these are not more than half the size of those of *P. puberula.*
Krameria lanceolata, Torr.
Abutilon parvulum, Gray.
Callirrhoë pedata, Gray. A small flowered form.
Callirrhoë involucrata (Nutt.), Gray, var. PALMATA (Buckl.) (C. PALMATA, Buckl. Proc. Phila. Acad. 1861, 449.)
Tribulus maximus, L.
Thamnosma Texanum (Gray), Torr.
Zizyphus obtusifolia, Gray.
Ceanothus ovatus, Desf.
Vitis rupestris, Scheele.
Vitis heptaphylla (Buckl.), Britt.
Sapindus marginatus, Willd.
Rhus radicans, L. The name has priority of place over *R. Toxicodendron* of the same author and claims adoption, as the two supposed species are quite inseparable.
Rhus Canadensis, Marsh. Arb. Amer. 129 (1785); (*R. aromatica,* Ait. Hort. Kew. i. 367 (1799).
Dalea nana, Torr.
Dalea formosa, Torr.
Dalea lasiatha, Gray.
Dalea laxiflora, Pursh.
Astragalus Mexicanus, A. DC.?
DESMODIUM TWEEDYI, n. sp. Intermediate in appearance between *D. canescens* (L.), DC., and *D. illinoense,* Gray. Stems stout, ascending, three feet or more high, channeled and ridged, at least in drying, minutely scabrous-pubescent; leaves large, petiole stout, 8 cm. long; leaflets ovate, 9 cm. long, 5 cm. broad just above the truncate base, the terminal one on a petiolule 3 cm. long, the lateral ones only about 3 mm.; leaflets all obtuse and strongly mucronulate, the upper surface glabrate,

the lower scabrous with minute pubescence on the strongly reticulated venation; stipules persistent, more than 1 cm. long, attenuate, acuminate; bracts similar but fugacious; panicle a foot or more long, few-flowered, flowers 8 mm. long, their pedicles elongating in fruit to 3 cm. and very slender; calyx 2 mm. long, its lobes acutish; joints of the pod rhombic, minutely canescent, slightly raised in the calyx, resembling those of *D. canescens*, to which species the plant appears to be most nearly related. The only pod on the specimen examined consists of but three joints.

Sophora affinis, Torr. & Gray.
Hoffmanseggia stricta, Benth.
Parkinsonia aculeata, L.
Cassia Rœmeriana, Scheele.
Cercis occidentalis, Torr. Possibly the *C. reniformis*, Engelm., which Dr. Watson reduces to a variety.
Prosopis juliflora, DC.
Mimosa Lindheimeri, Gray.
Mimosa fragrans, Gray.
Acacia Wrightii, Benth.
Acacia Greggii, Gray.
Lythrum alatum, Pursh.
Gaura coccinea, Nutt.
Œnothera speciosa, Nutt.
Cucurbita fœtidissima, Kunth.
Houstonia angustifolia, Michx.
Melampodium cinereum, DC.
Berlandiera lyrata, Benth.
Zinnia pumila, Gray.
Lepachys columnaris (Pursh.), Torr. & Gray, var. *pulcherrima* (DC.), Torr. & Gray.
Zexmenia hispida (H. B. K.), Gray.
Verbesina encelioides (Cav.), Gray.
Thelysperma longipes, Gray.
Hymenopappus flavescens, Gray.
Helenium tenuifolium, Nutt.
Helenium elegans, DC.?
Centaurea Americana, Nutt.
Perezia nana, Gray.
Lygodesmia aphylla (Nutt.), DC.
Pyrrhopappus Carolinianus (Walt.), DC.
Lobelia Cliffortiana, L., var. *brachypoda*, Gray.
Rhododendron nudiflorum (L.), Torr.
Philibertia undulata (Torr.), Gray.
Asclepiodora decumbens (Nutt.), Gray.
Asclepias verticillata, L., var. *subverticillata*, Gray.

Gonobolus biflorus, Nutt.
Erythræa Beyrichii, Torr. & Gray.
Phlox Rœmeriana, Scheele. Possibly only a form of *P. Drummondii*.
Coldenia canescens, DC.
Onosmodium Carolinianum (Lam.), DC.
Ipomœa Lindheimeri, Gray.
Cuscuta arvensis, Beyrich.
Solanum eleagnifolium, Cav.
Solanum Torreyi, Gray.
Solanum rostratum, Dunal.
Cestrum diurnum, L.
Ilysanthes gratioloides (L.), Benth.
Calophanes linearis (Torr. & Gray), Gray.
Ruellia ciliosa, Pursh., var. HUMILIS (Nutt.) (*R. humilis*, Nutt. Trans. Amer. Phil. Soc. v. [n. s.] 182 [1837]).
Verbena canescens, H. B. K.
Lippia lanceolata, Michx.
Lippia ligustrina (Lag.), Britt.
Teucrium laciniatum, Torr.
Salvia Texana, Torr.
Monarda citriodora, Cerv.
Marrubium vulgare, L.
Paronychia Jamesii, Torr. & Gray.
Amarantus spinosus, L.
Chenopodium leptophyllum, Nutt.
Polygonum emersum (Michx.), Britt.
Bœrhaavia linearifolia, Gray.
Euphorbia serpens, H. B. K.
Euphorbia Fendleri, Torr. & B. Gray.
Euphorbia Preslii, Guss.
Euphorbia angusta, Engelm.
Euphorbia Wrightii, Torr. & Gray.
Euphorbia, a woody species much resembling *E. buxifolia*, Lam., but probably different.
Croton Neomexicanus, Muell. Arg.
Stillingia angustifolia, Engelm.
Hicoria, a species of the Pacanier section, but with leaves quite smooth even when young, and remarkably punctate.
Juglans rupestris, Engelm.
Salix nigra, Marsh.
Cladium effusum, Torr.
Melica diffusa, Pursh., var. *nitens*, Scribn.
Eragrostis oxylepis, Torr.

ON THE GROUP OF METEORITES RECENTLY DISCOVERED IN BRENHAM TOWNSHIP, KIOWA COUNTY, KANSAS.[1]

BY GEORGE F. KUNZ.

About four years ago, the farmers of Brenham Township ploughed up a number of heavy objects, which they used to weight down haystacks and for other like purposes, as they would have used boulders. It was discovered in March last that these were not common "rocks," but an interesting group of meteorites, numbering over twenty in all, weighing together about 2,000 pounds, and individually from 466 pounds down to an ounce. They were found embedded at a slight depth in the soil, which here, for about 100 feet deep, is formed of a pleistocene marl, originally the bottom of an ancient lake; they

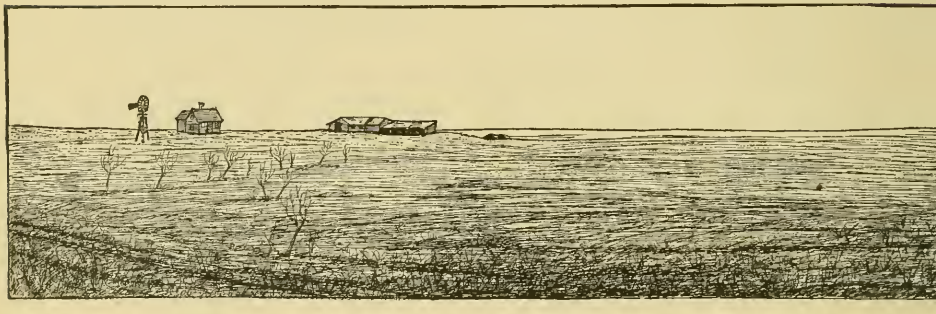

FIG. 1.—View of Kimberly Farm.

occurred scattered over a surface more than a mile in length, principally, however, in a square of about sixty acres.

What is now Kiowa County, Kansas, five years ago formed parts of Edwards and Comanche Counties, and was occupied by large ranges and cattle-ranches. Brenham Township, or Township 27, as it was then called, is in the northwestern part of Kiowa County, consists of high prairie with some areas of sand-hills, and has an altitude of about 220 feet above sea-level. Some drains of the head-waters of the Medicine River and its tributaries, further south, become ravines and valleys; and there a gravel occurs, the débris of miocene "Loup Fork" conglomerates. But on the high prairie not a stone of any kind is to be found; hence the ranchmen and settlers were greatly surprised at finding heavy "rocks" or stones projecting through the prairie sod. (Fig. 1.)

[1] Read April 7th, 1890.

Several years ago, Mr. Davis, a lawyer at Greensburg, identified these as meteorites; and although the farmers had thus known the fact for a long time, yet, strange to say, no importance was attached to them until Mrs. Kimberly applied to Prof. F. W. Cragin, of Washburn University, in the early part of last spring. It was not until the 13th of March that Prof. Cragin secured four of these masses.

They were nearly all found by being struck by mowing-machines, ploughshares, corn-cultivators, or other farm imple-

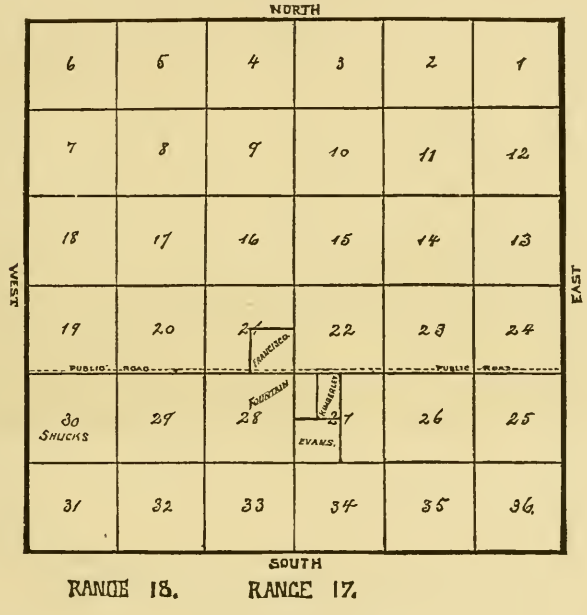

Fig. 2.—Brenham Township.

ments. Over twenty distinct masses have been reported; but it is very evident, from the weight and other facts, that some have been noted several times over.

The townships are reckoned from the base-line, the 40th parallel; and the ranges, from the 6th principal meridian, which crosses Kansas about longitude 97° 30′ W. of Greenwich.

Brenham Township [27] (Fig. 2) is made up of thirty-six sections, each one mile square, numbering from No. 1 to No. 36. The meteorites seem to have covered an area over one mile in length. Some of them fell on the east half of the northwest

quarter, Section 27, Township 28, Range 17, west of the 6th principal meridian.

The history of some of the pieces is remarkable. The 35.72-pound piece was found on the Evans place, was lost, and again found in a hole made by hogs under a barbed-wire fence. The 75-pound mass was used by Mrs. Kimberly to hold down a cellar-door or the cover of a rain-barrel. No. 3 was used to keep down a stable-roof (Fig. 3). The 466-pound mass (called by the farmers the "moon meteorite") was covered by only three inches

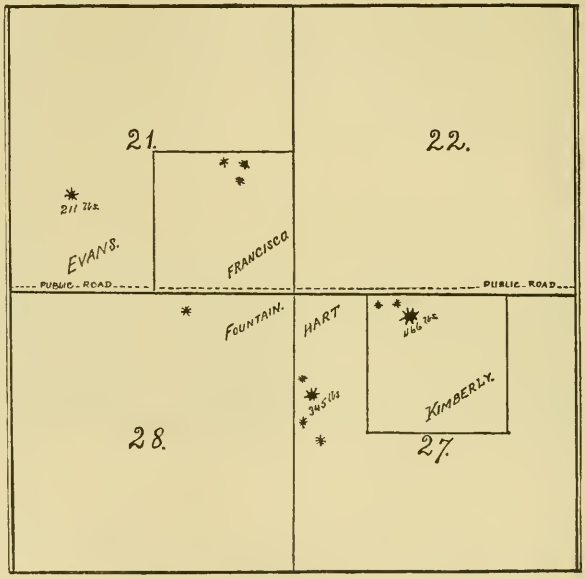

FIG. 3.—Diagram showing where the masses were found.

of soil, and broke a ploughshare when first struck. Apparently none of the masses were buried to a greater depth than five or six inches.

The 101.5-pound, the 71.5-pound, and the 55-pound masses were found four years ago by a cowboy, when the ranch had not yet been occupied by settlers, being simply used as a cattle-range. He was unable to move them to the "Green's Stage Station," now Greensburg, eight miles distant, and so buried them in the gulch a mile northwest of the Kimberly farm on the "Francisco Claim." About a year afterward he became ill and died; but before his death he communicated the burial of the "three strange rocks," as he called them, to two of the settlers, who

succeeded in finding them and bringing them to the new town of Greensburg about a year later. The 55-pound mass was carried over by a neighbor, who used it to weight down his haystack.

Prof. Snow, of Lawrence, Kansas, visited Kiowa County several times, and the last time obtained the 101.5-pound mass in the streets of Greensburg, the county seat, where it had lain for several years in front of a lawyer's real-estate office.

The exterior of all the masses shows the characteristic pitting. The surfaces have all been more or less oxidized by exposure to the elements, showing that the fall is not recent, and that the original mass was made of crystalline iron as well as of iron filled with crystals of olivine; in other words, the masses show two distinct groups. Of these, the 345-pound and the 75-pound ones are nickeliferous iron of a highly octahedral structure and cleavage, and are caillites; while the others are meteoric iron containing olivine, and belong to the group known as pallasites.

The largest mass, a pallasite, weighs 466 pounds, or 211.818 kilos. It is thick, slightly flattened, triangular in form, somewhat heart-shaped, and measures through the longest part 61 cm., or 24⅛ inches; across the widest part, 48 cm., or 19 inches; and in the thickest part, 37 cm., or 14½ inches. It is covered with large indentations measuring 10x6x3 cm. The coating is more or less oxidized, but the olivine is perceptible in all parts of the mass.

The dimensions of the 345-pound mass (156.818 kilos) are 60x37x29 cm., or 23¾x14½x11½ inches. It is slightly arch-shaped, is an iron with many pittings, and shows the characteristic magnetic oxide of iron crust.

The 219-pound mass (99.535 kilos) measures 51x41x26 cm. (20½x16½x10½ inches), in form like a three-sided pyramid.

The 211-pound mass (95.909 kilos) is somewhat rounded, with a circular depression on one side.

There are two masses weighing 125 pounds (58.863 kilos) and 54.96 pounds (25.084 kilos) respectively.

The 101.5-pound mass (46.136 kilos) is almost round, measuring 35x26x27 cm. (13¾x10¼x10¾ inches). The exterior is evenly pitted, and the centre of each pitting is occupied by an olivine crystal.

The 75-pound one (34.09 kilos) is an iron, and measures 32x22½x15 cm. (12½x8½x5⅞ inches), in shape like a pear or ham, covered with pittings. The crust has been changed somewhat by weathering.

The 71.5-pound mass (32.485 kilos) measures 27x23x22 cm. (10½x9x8⅝ inches). It is a jagged, irregular square, and shows olivine crystals all over the exterior.

The 60-pound mass (27.272 kilos) measures 36x21x17 cm.

(14⅛x8x6⅝ inches). It is an elongated, rounded piece, with one large flat side showing large spaces filled with olivine.

The 40-pound mass (18.181 kilos) measures 22x21x13 cm. (8⅝x8⅛x5⅛ inches), of irregular shape, with one large projecting point.

The 36-pound mass (16.363 kilos) measures 22x22x16 cm. (8½x8½x6¼ inches). It is a flattened spheroid, containing some olivine, but almost entirely iron, showing large pittings like the 75-pound and the 345-pound masses.

There are seventeen or eighteen small masses weighing 18, 12, 7, 6, 5, 3, and 1 pound respectively, and a few weighing only 1 ounce each. The 211 and 6-pound masses belong to the University of Minnesota; the 125-pound mass to Harvard University; the 101.5 to Yale University; the 218½ and the 54.96-pound masses to the University of Kansas. The others are in the collection of the writer.

The specific gravity of the pieces is very variable, and was found to be as follows:—Of the 6-pound mass, 5.17; 40-pound mass, 6.41; 71.5-pound mass, 5.22; 75-pound mass, 7.27; 345-pound mass, about the same density as the last; 466-pound mass, about the same density as the 71.5-pound mass.

The following analyses of the Kiowa meteorites were made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey:—

Iron.

	Per cent.
Fe	88.49
Ni	10.35
Co	.57
Cu	.03
P	.14
S	.08
C	tr.
Si	tr. ?
	99.66

Olivine.

	Per cent.
SiO_2	40.70
Al_2O_3	tr. ?
Fe_2O_3	.18
FeO	10.79
NiO	.02
MnO	.14
MgO	48.02
	99.85

Dark Outer Zone of Olivine.

	Per cent.
SiO_2	34.14
FeO	23.20
NiO	tr.
CoO	.03
MnO	.09
MgO	40.19
S	5.42
	103.07
Less O for S,	2.71
	100.36

The specific gravity of the iron freed from olivine was found to be 7.93 at 23.4° Celsius; of the olivine, 3.376 at 23.2°.

The iron is brilliant white, enclosing the troilite and surrounding the olivine crystals. Occasionally small etched surfaces show delicate figures like that of the Linnville Mountain meteorite.

Troilite exists plentifully, in rounded grains from one to five millimetres in diameter, and in thin folia mixed with and surrounding the olivine crystals, as well as running into and filling small spaces in the body of the iron, either as flat plates or rounded masses. Several flat circular plates [crystals ?] of graphite, two millimetres in diameter, were observed.

The olivine crystals are very brilliant, and break out entire, the faces on many of them being distinct enough to measure the angles. The spaces from which they break are highly polished, showing every crystal face with a mirror-like lustre; and in the centre there is a coating of a shining mineral that is jet-black in color, and crushes into a jet-black powder.

Many of the olivine crystals are in two distinct zones,—the inner half a bright transparent yellow, the outer a dark-brown iron-olivine. In reality this dark zone is an intimate mixture of troilite and olivine, as the analysis by Mr. Eakins and a microscopical examination of the crystals by Mr. J. S. Diller, of the United States Geological Survey, fully prove.

This group of meteorites, which has recently come to me for description, possesses more than ordinary interest, on account both of the peculiar composition and structure and also of the undoubted ethnological relation, especially because of its probable connection with the meteoric iron found in the Turner mounds. (Figs. 4 and 5.)

In the spring of 1883, Prof. F. W. Putnam found on the

altar of mound No. 3 of the Turner group of mounds, in the Little Miami valley, Ohio, several ear-ornaments made of iron, and several others overlaid with iron. With these were also found a number of separate pieces that were thought to be iron. They were covered with cinders, charcoal, pearls (two bushels were found in this group of mounds), and other material, cemented by an oxide of iron, showing that the whole had been subjected to a high temperature. On removing the scale, Dr. Kennicutt found that they were made of iron of meteoric origin.[1] One of the pieces weighed 28 and the other 52 grains.

In the autumn of 1883, a mass was found on the altar of a mound, No. 4 of this same group, which weighed 767.5 grammes (27.25 ounces). Dr. Kennicutt suggested that these were all parts of some larger meteoric mass. The results of the investi-

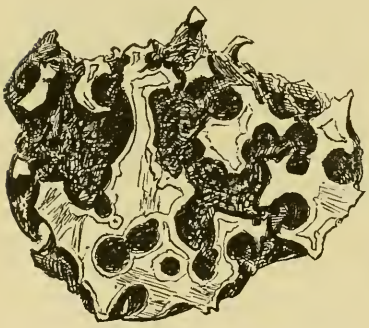

FIG. 4.—Kiowa County Pallasite.

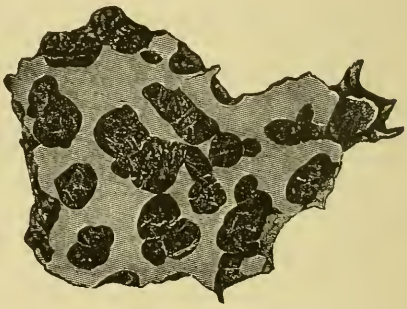

FIG. 5.—Turner Mound Pallasite.

gation were published in connection with the description of the Atacama meteorites, because in structure they approached more closely to the latter than to those of any other occurrence known at that time. In the Liberty group of mounds in the same valley, Prof. Putnam found a celt five inches long, and in another of the Turner mounds an ornament five inches long and three inches wide, made also of the same meteoric iron.

The Carroll County meteorite was found in 1880, about three-quarters of a mile from Eagle Station, Carroll County, Kentucky, ten miles from the mouth of the Kentucky River, and about seven miles in a direct line from both the Kentucky and the Ohio Rivers. The distance to the Turner mounds, where Prof. Putnam found the meteoric iron and the ornaments

[1] Sixteenth and Seventeenth Reports of the Peabody Museum of Archæology, p. 382.

made of it, is about sixty miles. The mass, which weighed about 80 pounds, or 36.5 kilos, was rusted on the surface to a depth, in some places, of ten to twelve millimetres; and deep pits, some two centimetres across, are observed in spots, where grains of olivine have probably dropped out. The meteorite was largely made up of fine, yellow transparent olivine, resembling that of the famous Pallas iron, with a specific gravity of 4.72.

Taking the specific gravity of the iron at 7.6, and that of the olivine at 3.3, we find that the Turner mound meteorite consists of about three parts of olivine to one of iron. Several of the Kiowa masses have about the same constitution. For comparison, see the analyses of the Kiowa meteorites, given above, and of the olivine and iron from the Turner mound,[1] here inserted, as follows:—

Olivine.

	Per cent.
SiO_2	40.02
FeO	14.06
MnO	0.10
MgO	45.60
	99.78

Iron.

	Per cent.
Fe	89.00
Ni	10.65
Co	0.45
Cu	tr.
	100.10

When the Carroll County iron was described by the author in the *American Journal of Science* [Vol. XXXIII., March, 1887], it was suggested that the pieces found by Prof. Putnam in the Miami mounds had probably been taken from that mass, since no other olivine meteorite had up to that time been found in North America; while that of Carroll County contained a large percentage of olivine, even greater than the mound specimens. Very little cutting had been done on the Carroll County mass; and it proved, on being cut, not to be a pallasite, but a brahinite variety of meteorite. In the Little Miami valley meteorite are embedded circular grains or crystals of olivine; whereas that of Carroll County consists of a mass of olivine in which the iron serves as a filling between the crystals. When a section

[1] Kennicutt: Sixteenth and Seventeenth Reports of the Peabody Museum of Archæology, p. 382.

was cut from the Kiowa County material, however, there appeared no doubt as to the identity of this fall with that from which the earrings were made that were found in the mound. In both the Kiowa County and the mound specimens the body of the meteorite is iron, in which are embedded circular masses or crystals of olivine. The fact that in connection with the large Kiowa masses a number of small portions, weighing from half a pound to six pounds each, were found, makes it very probable that a small mass, of perhaps three or four pounds, had been conveyed by the Indians to the Ohio valley. Probably the two earrings in the collection of Mr. Warren K. Moorehead, recently found by him at Fort Ancient, Ohio, may have been made from a part of the mass weighing 767.5 grammes, which is now in the Harvard University collection.

I must here express my indebtedness to Prof. F. H. Snow for information, and particularly to Prof. Robert Hay for aiding me in procuring many of the meteorites and assisting greatly to obtain exact data by visiting the place of discovery, and to secure the illustrations; as also to Mr. L. G. Eakins for making the analyses, and to Prof. F. W. Clarke, of the U. S. Geological Survey, for his courtesy in having them made in the Survey Laboratory.

METEORIC IRON FROM BRIDGEWATER, BURKE COUNTY, NORTH CAROLINA.

BY GEORGE F. KUNZ.

The Bridgewater, Burke County, meteorite was found by a negro ploughman, two miles from Bridgewater Station, latitude 35° 41′, longitude 81° 45′ W. of Greenwich, in the western part of Burke County, near the McDowell County line, in North Carolina. The negro thought, from its great weight, that it must be either gold or silver, and took it to some railroad laborers, who broke it in two pieces, one of which weighs 10½ and the other 18½ pounds, together 13.63 kilos = 30 pounds. The iron measures 22.5x15x10 cm. (9x6x4 inches). (See Fig. 6.)

Traces of black crust, very much oxidized, are still visible on the surface. The iron is highly octahedral in structure, and the mass was readily broken by the laborers who found it. Between the cleavage-plates schreibersite is visible.

On etching a polished surface with dilute nitric acid, the characteristic Widmanstätten figures were shown (Fig. 7); the iron belongs to the caillite group, and resembles in structure those of Cabin Creek and Glorietta Mountain. The specific gravity of a fragment was found to be 6.617. The following

analysis was kindly furnished by Prof. F. P. Venable, of the University of North Carolina:—

Fe	88.90
Ni	9.94
Co	.76
P	.35
Cl	.02
	99.97

The nickel is the mean of two determinations, 9.74 and 10.14,

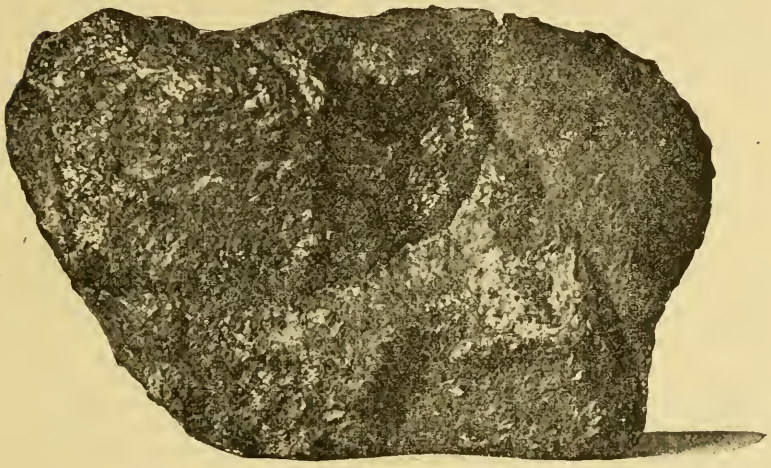

Fig. 6.—Bridgewater, N. C., Meteorite, ⅜ natural size, linear.

on different parts of the sample; and the cobalt also of two determinations, 0.85 and 0.67.

The iron is the mean of four determinations, some of which

Fig. 7.—Bridgewater, N. C., Meteorite; polished section, natural size.

were not very closely agreeing, as the crust could not be entirely removed from the samples taken.

The phosphorus and chlorine are single determinations.

The author takes pleasure in thanking Mr. F. K. Brunner for his courtesy in obtaining the information and the iron for him, and Prof. F. P. Venable for furnishing the analysis.

METEORIC IRON FROM SUMMIT, BLOUNT COUNTY, ALABAMA.

BY GEORGE F. KUNZ.

This mass of meteoric iron comes from near Summit, Blount County, Alabama, latitude 33° 41′, longitude 86° 25′ W. of Greenwich, in Fraction A, Section II., Township 10, Range I., East, where it was found by a six-year-old negro girl, who used it to crack hickory-nuts. Its great weight excited some curiosity, and her brother sent it to Mr. St. John, of Summit, and

FIG. 8.—Summit, Ala., Meteorite, ⅜ natural size, linear.

through the courtesy of Prof. Eugene A. Smith it passed into the possession of the writer.

It measures 12.5x5x7.5 cm. (5x2x3 inches) and weighs 1 kilo (2.2 pounds). (See Fig. 8.)

This meteorite contains a large quantity of free chloride of

Fig. 9.—Summit, Ala., Meteorite; polished section, natural size.

iron (lawrencite), which from time to time has formed in beads on the surface. It showed only a slight trace of the original crust and was almost completely oxidized; and on etching a polished surface of this iron with nitric acid, no Widmanstätten figures were developed, but instead a banded appearance, as shown in Fig. 9.

The specific gravity of a fragment was 6.949.

The following analysis was kindly furnished by Prof. F. P. Venable, of the University of North Carolina:—

Fe	93.39
Ni	5.62
Co	.58
P	.31
	99.90

The iron is the mean of three fairly agreeing determinations; the nickel, of two determinations, 5.61 and 5.63; the cobalt, of two determinations. The phosphorus is a single determination.

I take great pleasure in thanking Prof. Eugene A. Smith for his courtesy in obtaining the iron, and Prof. F. P. Venable for furnishing the analysis.

METEORIC IRON FROM COLFAX TOWNSHIP, RUTHERFORD COUNTY, NORTH CAROLINA.

BY GEORGE F. KUNZ.

This mass of meteoric iron was found by Amos Franklin, in the spring of 1880 or 1881, while working on the farm of Mrs. E. W. Dedmon, of Colfax Township, Rutherford County, North Carolina. As the specimen was found on the ground immediately after ploughing, it had evidently been turned up by the plough. It was then thrown on a wood-pile near the house, and was frequently beaten with an axe. A small piece was broken off by Mr. John Wilks, of Mecklenburg Iron-Works at Charlotte, N. C., on February 7th, 1890, and sent by him to Stuart W. Cramer, assayer in charge of the United States Assay Office at Charlotte, who identified it as meteoric iron.

Its weight is 72 ounces Troy,—2,400 grammes. It is about the size and shape of a double gourd, with three or four large indentations. The surface is slightly rusted, but there are still traces of black magnetic oxide of iron. At one end, where it was broken, the octahedral structure shows beautifully, and several octahedral cleavages are seen. In structure, it is very similar to that from Jenny's Creek, Wayne County, West Virginia (*Am. Jour. Sci.*, Vol. XXXI., Feb., 1886, p. 145), but it is tougher in its fracture. The etched surface shows the Widmanstätten figures very finely,—the markings being somewhat smaller than in the Glorietta Mountain meteorite. Between the cleavage laminæ are plates of schreibersite.

The following analysis was kindly furnished by Dr. Stuart W. Cramer, United States Assayer at Charlotte, N. C.:—

	No. 1.	No. 2.
Iron	87.69	89.22
Nickel	11.26	9.37
Cobalt	.62	.53
Copper	.05	.04
Phosphorus	.19	.19
Sulphur	.10	.08
Silica	.03	.01
	99.94	99.44

No. 1 and No. 2 are taken from different places; the results show it to be very variable in composition.

The meteorite from Lick Creek, Davidson County, N. C. (*Am. Jour. Sci.*, III., Vol. XX., p. 324, 1880), and that of Linnville Mountain, North Carolina (*Am. Jour. Sci.*, III., Vol. XXXVI., Oct., 1888), did not show the Widmanstätten figures; and as this is an entire mass, it is evidently a distinct fall.

The writer is indebted to Mr. Donald MacRae, of Wilmington, N. C., for his courtesy in assisting him in obtaining both the iron and the information regarding it.

ON THE METEORIC STONE FROM FERGUSON, HAYWOOD COUNTY, NORTH CAROLINA.

BY GEORGE F. KUNZ.

Mr. W. A. Harrison, of Ferguson, N. C., says that at about six o'clock on the evening of July 18th, 1889, he noticed a remarkable noise west of him, and that fifteen minutes later he saw something strike the earth. On examination, this proved to be a meteoric stone, so hot that he could scarcely hold it in his hand five minutes after it fell. Two-thirds of its bulk was buried in the earth when found. This stone was sent to the writer, and was unfortunately lost in New York City during the month of December.

The stone was slightly oblong, covered with a deep, black crust, which had been broken at one end, showing a great chondritic structure with occasional specks of iron. Its weight was about eight ounces; and it very closely resembled the meteoric stone from Mocs, Transylvania. It remained in the writer's possession so short a time that it was not properly investigated; but still the mere mention of a fall which had been so carefully observed is thought to be worthy of publication.

May 12, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

One hundred persons present.

The PRESIDENT nominated Mr. A. C. CHENOWETH as Resident Member.

The paper of the evening was then read:—

AN ACCOUNT OF THE RECENT EXCAVATIONS IN ANCIENT MOUNDS AT INWOOD, NEW YORK CITY.

BY W. H. J. SIEBERG AND A. C. CHENOWETH.

(Abstract.)

This communication was illustrated with a very large series of specimens, comprising pottery, stone implements, and human bones, some skeletons being nearly complete.

PROF. D. S. MARTIN described briefly the location and other peculiarities of the mound. It lies in a valley formed by the erosion of one of the limestone belts of that part of the island, between two of the gneissic ridges on either side,—one of them forming the line of heights along by the Hudson, and the other, to the east, the celebrated mineral locality of Fort George. The limestone (dolomite) has weathered away upon the outcrops to an exceedingly clean, dry, crystalline lime-sand,—closely resembling "granulated" sugar. This makes a remarkable preserving material for such remains as those here found. The "mound" itself is a rounded swell of this decomposed dolomite, not an artificial structure such as those of the West. As regards the age of the relics, their extraordinary state of preservation is the first fact that impresses one; but this is doubtless due, as said, to the character of the soil. The pottery, however, is abundant, and unquestionably of a rude aboriginal type. This, with the trees growing over the burial-spots, and the size and other peculiarities of the remains, are a sufficient attestation of the genuineness of the locality as an old Indian grave-mound, however we may regard its claim to extreme antiquity.

At the close of the paper there was considerable discussion

by Messrs. NEWBERRY, DOUGLAS, POWERS, SIEBERG, and CHENOWETH. The result of this discussion was that it was too early to come to any definite conclusion as to the value of these discoveries. Messrs. SIEBERG and CHENOWETH promised to submit a later account of their excavations.

MR. GEORGE F. KUNZ exhibited specimens of a meteorite which fell on May 2d, 1890, 11 miles from Forest City, Winnebago Co., Iowa; the larger fragments weighed respectively 104 pounds, 70 pounds, and 10 pounds.

MR. KUNZ also exhibited specimens of hydrocarbon minerals from Yuma County, Arizona.

May 19, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

One hundred and twenty-five persons present.

A supplementary lecture was given by MR. GEORGE F. KUNZ on

THE PARIS EXHIBITION OF 1889,

illustrated by a large number of beautiful lantern slides.

May 26, 1890.

STATED MEETING.

The President, DR. NEWBERRY, in the chair.

Twenty-five persons present.

It was announced by the PRESIDENT that the evening was devoted to a joint meeting of the Section of Mineralogy and the New York Mineralogical Club.

The first paper announced was that of Mr. F. J. H. MERRILL on

THE SERPENTINES OF NEW YORK AND VICINITY.[1]

MR. MERRILL'S paper was discussed by DR. NEWBERRY and PROF. MARTIN, who expressed great interest in the very com-

[1] Mr. Merrill will furnish an abstract of this paper for Vol. X.

plete and satisfactory account presented of the chemical processes by which these serpentine rocks have been formed.

Mr. George F. Kunz read his paper, illustrated by specimens and photographs, on

THE AEROLITES WHICH FELL MAY 2D, 1890, IN WINNEBAGO COUNTY, IOWA.

On Friday, May 2d, 1890, at 5:15 P.M., standard Western time, a meteor was observed over a good part of the State of Iowa. It is described as a bright ball of fire, moving from west to east, leaving a trail of smoke which was visible for from ten to fifteen minutes; it was accompanied by a noise likened to that of heavy cannonading or of thunder, and many people rushed to their doors, thinking it was the rumbling of an earthquake. Substantiated reports have been received from Des Moines, Mason City, Fort Dodge, Emmetsburg, Algonia, Ruthven, Humboldt, Britt, Garnet, Grinnell, Sioux City, and Forest City; the noise was also heard at Chamberlain, South Dakota. Some of these places were distant more than a hundred miles from the point where the meteor fell. It exploded about eleven miles northwest of Forest City, at Leland, Winnebago County, in the centre of the northern part of Iowa, latitude 43° 15′, longitude 93° 45′ west of Greenwich, near the Minnesota State line, and the fragments were scattered over an area one mile wide and nearly two miles long. Up to the present time, there have been found masses weighing respectively eighty pounds, sixty-six pounds, and ten pounds, two of four pounds, and about five hundred fragments weighing from one-twentieth of an ounce to twenty ounces each, while a part of the mass is believed to have passed over into Minnesota. The pieces are all angular, with rounded edges.

This meteor is a typical chondrite, apparently of the type of the Parnallite group of Meunier, which fell February 28th, 1857, at Parnallee, India. The stone is porous, and when it is placed in water to ascertain its specific gravity there is a considerable ebullition of air. The specific gravity, on a fifteen-gramme piece, was found to be 3.638. The crust is rather thin, opaque black, not shining, and, under the microscope, is very scorious, resembling the Knyahinya (Hungary) and the West Liberty (Iowa) meteoric stones. A broken surface shows the interior color to be gray, spotted with brown, black, and white, the latter showing the existence of small specks of meteoric iron from one to two millimetres across. Troilite is also present in small rounded masses of about the same size. On one broken surface

was a very thin scum of a black substance, evidently graphite, soft enough to mark white paper; a feldspar (anorthite) was likewise observed, and enstatite was also present.

Professor H. A. Newton says: "The path that satisfies best the accounts that appear to be reliable was directed from a point a little north of west and somewhat higher than the sun, the sun being then about 20° high and due west. The velocity of the meteorite may be safely assumed to have been greater than that of Encke's comet at distance unity, and less than that belonging to a parabolic orbit. With this assumption the orbit would be inclined to the ecliptic between 10° and 20° with direct motion. The ascending node is in longitude 42.5°. The body had passed perihelion several weeks, how long depends mainly upon the inclination to the horizon of the path through the air. The perihelion distance was probably between 0.50 and 0.70, this element also being largely dependent upon the same inclination. Better observations of this inclination than are now in hand are hoped for."

This is the fourth meteorite that has been seen to fall in Iowa. The other three falls were as follows: At Hartford, Linn County, February 25th, 1847; at West Liberty, Iowa County, February 12th, 1875; and the great fall of siderolites at Estherville, Emmet County, May 10th, 1879, which comprised over two thousand pieces weighing from one-tenth of an ounce to four hundred pounds.

The following analyses and note are kindly furnished by Mr. L. G. Eakins, of the laboratory of the U. S. Geological Survey:

Approximate Composition of the Mass.

Nickeliferous Iron	19.40
Troilite	6.19
Silicates soluble in HCl	36.04
Silicates insoluble in HCl	38.37
	100.000

Analysis of the Nickeliferous Iron.

Fe	92.65
Ni	6.11
Co	.65
P	tr.
S	tr.
	99.41

Specific gravity of the mass, 3.804 at 28.5° Celsius.

Analysis of the silicious portion with the magnetic extracted.

	Soluble in HCl.		Calculated to 100%.			Insoluble in HCl.	Calculated to 100%.
	[1]		[2]	[3]		[4]	[5]
SiO_2	17.82		17.82	39.74	SiO_2	26.49	55.51
					Al_2O_3	2.59	5.43
FeO	14.27	6.01 FeO, equiv. to 4.67 Fe, required by S to form FeS	8.26	18.42	Cr_2O_3	.12	.25
					FeO	4.49	9.45
NiO	.17		.17	.38	NiO	tr.	
MnO	tr.		tr.		CaO	1.45	3.00
CaO	.31		.31	.69	MgO	11.50	24.09
MgO	18.28		18.28	40.77	K_2O	.07	.15
Alkalies	tr.		tr.		Na_2O	1.01	2.12
S	2.67	2.678 to form FeS				47.72	100.00
P_2O_5	tr.		tr.				
	53.52		44.84	100.00			
O for S	1.34						
	52.18						

The approximate composition of the mass was got by extracting everything possible by an electro-magnet, which took out all the nickel iron and a little troilite, leaving the silicious part and most of the troilite. Then the amount of S present in the magnetic portion, and that in the silicious portion, was calculated as FeS; the silicates were split into two portions by HCl, and by the weights found in each case the given approximate composition was calculated. Under the head of analysis of nickeliferous iron is given the analysis of the metallic portion after allowing for a very slight amount of attached silicates and troilite.

The analyses numbered from 1 to 5 are the residue left after removing all the magnetic material. Column 1 is the part soluble in HCl, column 4 that insoluble in HCl; these two added together would give the analysis as a whole of the non-magnetic portion. Column 2 is the same analysis as 1, after removing the 2.67% S and an amount [6.01%] of FeO equivalent to the Fe necessary to form troilite with the S. Column 3 is the same as 2 calculated to 100%. Column 4, as stated, is the analysis of the insoluble portion, and 5 is the same to 100%. It is of course probable that the Cr_2O_3 represents chromite, and possible that the alkalies and alumina with a little lime represent a soda-lime feldspar.

The author takes great pleasure in thanking Mr. L. G. Eakins and Prof. F. W. Clarke for their kindness, the former in furnishing the analysis, and the latter in assisting with it.

June 2, 1890.

REGULAR BUSINESS MEETING.

No quorum. Adjourned to June 9th.

June 9, 1890.

ADJOURNED BUSINESS MEETING.

In the absence of any of the regular officers, PROF. D. S. MARTIN was appointed Temporary Chairman.

About fifty persons present.

The following recommendations of the COUNCIL were read:—

I. Payment of the following bills:—

Printing ballots and notices of meetings	$48.75
Illustrations for the ANNALS	12.00
Minor expenses	6.26
	$67.01

II. The election of MR. A. C. CHENOWETH as Resident Member.

III. The appropriation of $100 to bind books in the library, and $6 to illustrate the paper of MR. P. H. DUDLEY.

The recommendations were approved, and the Secretary was directed to cast a ballot in favor of MR. CHENOWETH, which was done.

The following bills, having been presented after the meeting of the COUNCIL, were read, approved, and ordered paid:—

Janitor's services (May)	$12.00
Distributing publications	4.85
Printing TRANSACTIONS, Vol. IX., Nos. 3 and 4,	89.80
	$106.65

The following preamble and resolution amending Chap. X., Sec. 1, of the By-Laws, approved by the COUNCIL, was read:—

Whereas, The income derived from invested securities amounts

to $218.39, and every year the premium on the U.S. 4 per cent consols is steadily decreasing, and whereas by investing the securities in a 5 per cent bond and mortgage the annual income would be increased to $327.80; therefore it is

Resolved, That Chapter X., Section 1, of the By-Laws be amended so as to read as follows: All such contributions and other permanent funds of the Academy shall be invested in United States or in New York State securities, or in bonds and mortgages on improved real estate in the cities of New York or Brooklyn; and further be it

Resolved, That the Treasurer, with the approval of the Council, be authorized to sell the United States 4 per cent consols and invest the proceeds of such sale, together with the savings bank moneys, in a good and proper bond and mortgage, such bond and mortgage to be approved by the Council and the Finance Committee.

This resolution was amended by inserting after "Brooklyn" the words "which shall be a first lien thereon, and shall not exceed 65 per cent of the value thereof." In this shape the resolution will lie over until the October meeting, and may then be acted upon.

Statement of the condition of the assets of the Academy, showing the increased income to be derived by proposed change:—

$3,800 U. S. Govt. 4 per cents, coupon,		
300 " " " " registered	$4,100	00
Premium at 22 per cent	902	00
Publication Fund (Savings Bank)	658	80
General Fund	895	37
Total assets	$6,556	17
Interest on $6,556.17 on bond and mortgage at 5 per cent	$327	80
Present income	218	39
Balance in favor of bond and mortgage	$109	41

Prof. Martin read the following papers by title:—

(I.) THE NEW METEORIC IRON FROM PULASKI CO., VIRGINIA.

(II.) METEORIC IRON FROM BUTTE, MONTANA.

BY GEORGE F. KUNZ.

Mr. E. B. Dunn, of the U. S. Signal Service, read a paper entitled

THE CHANGE IN OUR CLIMATE, AND THE CAUSE.

(Abstract.)

The question of a change in our climate, whether viewed in a scientific or purely physical sense, must be of more or less interest to each of us.

It is the general belief that our climate is undergoing a change, and the subject has been the cause of much discussion by the press and public, especially during the past two years. Scientifically, little has been done to prove to what extent the change has been.

By the kind permission of the Academy, I will present a few facts and figures that will show the amount of the change, and, I hope, lead to a solution of the cause, not alone in this vicinity, but throughout the entire country.

The question of a change in climate is not a new one; it has been discussed in this country and Europe in past years, without reaching any definite conclusion; but the present circumstances differ materially from those formerly investigated, and a research into the subject may prove far more beneficial to American industries (principally agriculture) than is generally supposed.

To establish as a fact the change of a climate from any cause, whether it be apparent or occult, necessitates years of careful observation. We must therefore deal cautiously with the few facts at hand before coming to any definite conclusion as to the change in our climate being a temporary or permanent one.

The most noticeable change that has occurred in this vicinity has been the warm winter months of 1888, 1889, and 1890.

According to the figures of the Signal Office in this city, the highest annual mean temperature for the past 19 years was 53.5° in 1889, and the lowest, 48.6° in 1875; confining the range of annual mean temperature to 4.9°, and making the annual mean 51.3°, the records show that since 1876 there has been an increase of heat in this city, except for the years 1885, 1886, and 1888, those years showing a slight deficiency.

Not a single year up to 1882 did we receive our full amount of heat; in most cases the winters were long and severe. At the close of 1882 the annual mean temperature just equalled the normal; since then, except in the three years mentioned, there has been a surplus, and in the last two years the increase was most marked. In comparing the year 1875, which is the coldest on record and has a deficiency of 1,029° mean temperature, with the year 1889, which is the warmest on record and has an excess

of 845° mean temperature, we find a difference of 1,874° mean temperature between the extremes of these years; such a change can hardly be realized, and would be instantly doubted were it not for the figures of most reliable records.

During the year 1875 the temperature in this city ran below the freezing point on 114 days, and on 37 days remained below for the entire day; the lowest temperature was 6° below zero, which occurred on the 10th day of January, and was, by the way, the lowest temperature ever recorded by the Signal Office in this city.

Now, to compare the year 1889, we find the temperature recording below the freezing point on 59 days only, 55 days less than 1875, and on 14 days only did the temperature remain below freezing for the entire day, 23 days less than 1875; the coldest day was February 24th, 2° above zero.

The more noticeable change and increase of heat began with the month of November, 1888, and continued unremittingly to the present time, except during the months of July, August, and September. The greatest excesses take place during the winter months; the month of August shows a deficiency, and, strange to say, the mean temperature for that month for the past eight years has been below the normal; and the months of July and September show a loss of heat during the past two years, but not of such marked degree as August.

Since January 1st, this year, we find the same excess taking place, only more rapidly and to a greater extent than in 1889; in that year the surplus heat for January was 211°, while the same month this year shows an excess of 328° mean temperature above the normal, an increase of 156° for February, 44° for March, and 152° for April, the month of May closing with an excess, since January 1st, of 789°, or 253° more than for the same period of 1889. This great increase enables us beyond a doubt to say that a change has and is still taking place in our climate, and assures us of two things: first, that the greatest excess of heat occurs in our coldest months, modifying them to such an extent as to compare favorably with our Southern winters; second, that the months of July, August, and September have a tendency to be cooler than the mean. There must be considerable comfort derived from the latter fact, for should the heat continue to be received at its present rate of increase throughout the warm months, it would be almost unbearable. But it is my belief that the summer months will greatly reduce the surplus heat already received; if not, the winter months must be decidedly colder than usual to have the counterbalancing effect of cutting down this year's excess and bringing the annual mean temperature within the range of the past nineteen years, otherwise the theory that our climate is changing will be greatly strengthened.

Now the question arises, What has been the cause of the change ?

Many theories have been advanced, but the general public are at a loss to account for it from an ordinary basis of calculation; some have ascribed it to an inshore drifting of the Gulf Stream, and, without looking further, have satisfied themselves that that solves the problem ; others to an increase of sun-spots ; and some, the early breaking up of polar ice. But in each case facts to verify the theories have been lacking. It is my belief, and the following facts advance the theory, that a change in the course of storms, superinduced by irrigation and increased rainfall on our Western plains, is the cause of the unnatural weather of the past and present that is taking place, not alone in this vicinity, but over the entire country.

After a careful investigation of the subject, the scientific bureaus of the Government fail to show that there has been any change in the course of the Gulf Stream; and even had it been shown that a change had taken place, all the facts in a meteorological sense bearing on the subject are at variance with the theory. Should that stream literally wash our shores, it could not materially change our climate; the effect would be but intermittent and of so long duration proportionately with the wind blowing on shore; and then only on the immediate borders of our coast would there possibly be a perceptible increase in temperature.

The Gulf Stream theory must be disposed of when it is shown that all our areas of high and low pressure move to the eastward, that our prevailing wind is from the southwest, and the areas of cold and warm waves pass off the coast. It must be readily observed that, in conformity with the earth's rotation, all atmospheric conditions travel to the eastward. In direct opposition to the Gulf Stream theory is the established fact that the same excessive heat felt on the Atlantic seaboard prevailed for the same period throughout that country which lies between the Alleghany and the Rocky Mountain systems.

At 58 out of a total of 89 regular stations of the Signal Service east of the Rocky Mountains having a record of ten years or more, and at the older established stations in New Mexico, Arizona, and Utah, the mean temperature for the month of December, 1889, was the highest ever reported, and at 41 of these stations the absolute maximum temperature was higher than that noted for the same month of preceding years; while west of the Rocky Mountains there was a deficiency in temperature, frosts occurring as far south as San Diego on several occasions.

In making a comparison of the month of January, I find it

warmer than the average at all places east of the Rocky Mountains, except in Minnesota and the Upper Missouri Valley, and much colder than the average for the month on the Pacific coast; the greatest excesses occurred in the Middle Atlantic States south of New York, in the Ohio valley, lower Mississippi valley, and the southern Rocky Mountain region. The greatest departures below the average occurred in northern Montana, Nevada, and eastward over the British possessions and Canada.

For the month of February we find the same excesses of temperature taking place east of the Rocky Mountains, and a falling-off of heat on the Pacific coast, also in the northern part of the United States and Canada. In making a comparison of the winter of 1889 and 1890, it is readily seen that the change has been general and the Gulf Stream effect could be but local.

Within the last year or two most of our storms have travelled across the country north of this city, generally about latitude 45°, some much higher, and have followed each other in such rapid succession that it was only on rare occasions that an area of high pressure with a cold wave could slip down from the Northwest and overspread this part of the country. During the months of December, 1889, January and February, 1890, but one storm centre passed south of this city, which is one factor in accounting for a scarcity of cold weather; the same period embraces 28 well-defined storm centres which passed north of this city, each in turn causing a steady flow of warm air from the south northward over the central valleys and this region.

In former years it was also found that a majority of the storms passed north of this city, but the interval of time between their passage was greater, and they were generally followed by an area of high pressure that would extend over a greater part of the country.

The number of storms passing off the coast south of New York averaged about one-third of the number that passed north; each of these drew a cold wave directly over the city. In the cold year of 1875, during the months of January, February, November, and December, forty-two storms passed over the country; eleven passed south of this city, and the remainder to the north,—ten more to the south than for the winter of 1889 and 1890. During the research I found that for the past few years many of our storms originated in the great interior plateau of the Rocky Mountains; some formed very rapidly, taking up a course over Colorado or Wyoming, travelling on to the great lakes; others formed very slowly, sometimes with little or no energy, until the whole mountain system would be enveloped

in one oblong barometric depression stretching over several States or Territories, ofttimes being divided by areas of high pressure, forming two distinct storm centres of what was the barometric trough. These latter storms invariably passed over the irrigated lands of either Colorado or Wyoming, and sometimes Nebraska and Kansas. Those storms which passed into our country from the Northwest or Southwest, with but few exceptions, took the same course across some of the States mentioned and where irrigation existed ; some appeared to be drawn hundreds of miles out of their regular course into the irrigated lands. During the year 1888 sixty-two storms passed directly over or were drawn into the irrigated region, while in the year 1889 the total number was sixty-seven. The increased number of depressions forming in Colorado, Wyoming, and the plateau of the Rocky Mountains, and also many storms that formerly followed a track across the country from the Southwest, and usually passed off the coast south of New York, have in later years, with but few exceptions, left what appeared to be the more natural course and travelled in a more northerly direction toward the irrigated lands, and there, with a fresh accumulation of vapor, started with renewed vigor for the great lakes.

All storms, like the electric current, follow a path of the least atmospheric resistance. An increase of moisture offers extra attraction where storms pass over a dry country; the immense area of country surrounding the irrigated lands offers resistance to the storm's movement on account of its dryness, and instead of passing over thousands of miles of such land they take up a course which offers the greatest attraction and least resistance, — over the artificial waterways.

As late as 1874 irrigation on the Western plains was almost unknown. The city of Denver was watered from small irrigating ditches; the water was carried from the mountains, 12 or 13 miles distant, and on set days of each week would be turned on and allowed to run through certain streets of the city. The rainfall was inadequate to supply the necessary moisture to the smallest plants, so, to water the ordinary house gardens, small sluices were cut from what we call gutters to the small patch of ground under cultivation. The water was allowed to run on two or three days of each week, not more. It was impossible at that time for a person to raise enough corn to feed one horse; all the produce required was transported at an enormous expense from the Mississippi valley or California. Since then the system of irrigation has gradually expanded, until 4,300,000 acres of the most fertile soil are made available for raising crops of all sorts in abundance, and more than enough for home consumption. According to the figures of Mr. C. E. Dutton, Chief En-

gineer of the Geological Survey, to whom I am indebted for the following facts, Colorado has to-day 3,550 square miles of her land under irrigation; Wyoming, 780 square miles; Utah, 1,250 square miles; and Kansas and Nebraska less than 100 square miles each, making a total of about 6,730 square miles. This spreading of water over the principal portion of the central plains has induced an increased rainfall, but to what extent or amount is not easily determined. Comparative tables show the increase in some months to be most remarkable; then in a year or two following there is a considerable deficiency. But it is safe to say that all indications point to an increase,—if not in a perceptible fall of rain or snow according to measurement, then in the depositing of moisture in the form of dew, thus nourishing and sustaining wheat fields and farms, even outside of the reach of irrigation; which bears evidence of the fact that the moisture in that part of the country is increasing, whether it comes from actual rainfall or deposits of dew. The large amount of water thinly spread over such an immense area must either be absorbed by the ground or evaporated; at any rate, a certain percentage is evaporated, for evaporation goes on at all times and under all atmospheric conditions. During the warmer part of the day the atmosphere is capable of containing the most moisture, and in that country where few clouds exist, and the sky at night is perfectly clear and transparent, the radiation is rapid and the condensation of moisture takes place almost as soon as the sun sets. By light winds the moisture may be carried for miles from where it has been gathered during the day, and deposited outside the fields of irrigation, thus accounting for the fertile and pliable soil where nature alone supplies the moisture. The planting of trees and general vegetation on what was a barren waste has a further tendency to increase the rainfall, and the larger the area covered the greater will be the influence to prevent a relapse. The evidence of a steady increase in rainfall is not as conclusive as might be desired, but the evidence of increased moisture is plainly shown.

Now, we find that during the past ten years immense tracts of land in the States of Colorado, Utah, Wyoming, Kansas, and Nebraska have greatly advanced in the system of irrigation. Colorado has by far the largest irrigable area, and furnishes water sufficient to cover over 2,000,000 acres.

To sum it up, we have shown, first, that the change that has taken place in our climate is due to a change in the course of storms; and, second, that that change in the course of storms is induced by the irrigated lands of the West.

Now the question arises, What will be the effect upon our climate of further irrigation?

Two reports are before the United States Senate Committee on the Irrigation and Reclamation of Arid Lands. One sets forth that the total area of the United States, exclusive of Alaska, is a little more than 3,000,000 square miles, and that one-third of it must have artificial irrigation to insure regular annual crops. This arid land is situated on either side of that already under irrigation.

In my opinion the permanency of a change in our climate depends entirely upon the action taken in further irrigation. If the lands in the Northwest are first irrigated, the effect will be to have a continuance of our storm tracks over the higher latitudes; on the other hand, should the Southwest lands be first reclaimed, the storms would assume their former course and a greater number would pass off the coast south of New York, thus drawing down upon us the cold waves as in former years. And it is my belief that we will continue in the same climatic condition until the entire Western plains are under a complete system of irrigation.

At the conclusion of this paper, it was announced that the Academy would adjourn until the first Monday in October.

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ERRATA.

Page 129. 24th line, read 1731 instead of 1831.

Page 156. Lecture Evening instead of Stated Meeting.

Page 200. Lecture Evening instead of Stated Meeting, May 19th.

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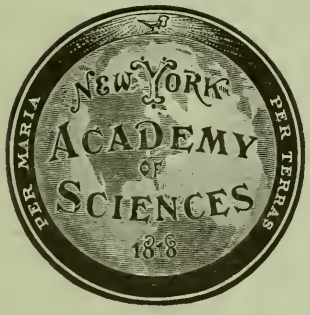

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